STUDIES OF NORTH AMERICAN PLECOPTERA (PTERONARCINAE AND PERLODINI)

BY LUCY WRIGHT SMITH

Introduction

Plecoptera, or stone-flies, are of universal distribution; they are found on all the continents and in all climates from the arctic region to the tropics. For the most part the adults are dark brown, inconspicuous insects with elongate, depressed bodies, long, slender antennae and setae, and two pairs of membranous wings which lie folded over the body in a horizontal position when the insects are at rest. In general, stone-flies are poor fliers and can be found crawling around the stones, on banks of streams or on nearby trees much oftener than on the wing. Ordinarily they are not seen in great numbers on account of their more or less protective coloration and their habit of crawling away into hiding in cracks and crevices. The immature form, the nymphs, are found much more abundantly. These can be seen in almost any stream, on the under side of stones, or hidden away in masses of drifted leaves. Aside from the absence of wings, they are much like the adults in form. The majority of them possess tracheal gills, situated usually on the ventral side of the thorax, but they may occur on the under side of the head, on the basal abdominal segments, or at the tip of the abdomen.

Despite the wide distribution of stone-flies and their comparative abundance, a large collection of them is rarely found in the possession of institutions or individuals. Likewise, the amount of work, that has been done on the order, is very small. A few systematists have been interested in them and have described a good many, but aside from that they are little known. Only occasionally has some biological or morphological aspect of a genus or species attracted anyone's attention.

My own interest in the group is primarily ecological, and my first two years' study of it was of that nature. During that time many life-histories were obtained, and considerable interesting data were accumulated on such things as emergence, feeding

habits, egg-laying and mating. In attempting the identification of the material upon which I was working, a great lack of detailed systematic knowledge was keenly felt. In many instances original descriptions are inadequate both on account of their brevity and also because of the characters chosen for the basis of the descriptions. Coloration, which is exceedingly variable in the group, has often served as the chief character. Venation has been used also, but here again the inconstancy of certain characters that were selected, such as the number of tips of veins or the number of cross-veins, makes them of little value. The need for a more complete systematic working basis seemed so great that, at Prof. Needham's suggestion, the ecological work was put aside temporarily, and such a study commenced.

Prof. Franz Klapálek (Prague, Bohemia), who has done perhaps more than anyone else on the group in recent years, has used with considerable success genital and venational characters as the basis for his descriptions. In my own work on the North American forms I am also making them the essential characters in my descriptions. The genitalia of this order are not only constant in form for each species, and, therefore good characters, but they are so diverse, and, in many instances, so remarkable, that they are unusually distinctive. Although stone-flies are very primitive in many ways they have reached a high degree of specialization in this respect. Quite apart from their value systematically, the genitalia are intensely interesting, on account of their complexity, from morphological and physiological viewpoints.

In the order Plecoptera I recognize a single family and four sub-families:

Perlidae { Pteronarcinae
Perlinae
Nemourinae
Capninae

The present study, which is only a beginning of a monograph of the order, treats the Pteronarcinae and a portion of the Perlinae under the tribal name Perlodini. This sub-family and tribe can be distinguished from all other Plecoptera on the presence of an apical network of supernumerary cross-veins. In the Pteronarcinae the network extends in the fore-wing from costa through the anal veins. In the Perlodini it is of greater or less extent but

is restricted to the anterior part of the wing, never extending in the fore-wing posterior to the cubital veins. In the genus *Acroneuria* the network is more sub-apical and is confined to the region between cubitus, and the posterior branches of the radial sector.

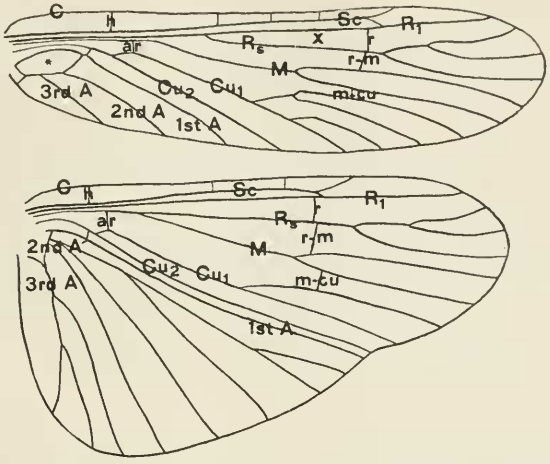

FIGURE A.—Diagram of Plecoptera Venation.

In the venation of the Plecoptera (fig. A) we recognize in both wings the following longitudinal veins; C = costa; Sc = sub-costa; R = radius composed of R_1 = radius$_1$ and Rs = radial sector; M = media; Cu = cubitus, composed of Cu_1 = cubitus$_1$, and Cu_2 = cubitus$_2$; 1st A = first anal vein; 2nd A = second anal vein; 3rd A = third anal vein. A few cross-veins recur constantly; they are, h = humeral; r = radial; ar = arculus; r-m = radio-medial; m-cu = medio-cubital. Two cells of the fore-wing, x = inner inter-radial cell, and the anal cell, designated by an asterisk in the diagram, furnish additional venation characters.

An extensive examination of material has been made possible in this study through the kindness of a number of institutions which have loaned us their Plecoptera collections. I wish to thank most heartily the Museum of Comparative Zoology, the Academy of Natural Sciences of Philadelphia, the United States National Museum, the Illinois State Laboratory of Natural Sciences, and the State Museum in Albany.

Furthermore, we are greatly indebted to Prof. T. D. A. Cockerell, Prof. J. C. Bradley, Mr. P. B. Powell, Prof. C. P. Gillette, Prof. C. W. Howard, Mr. H. A. Surface, former State Zoologist of Pennsylvania, and Miss Hortense Butler for the collection of valuable material.

Finally, I wish to express my most sincere gratitude to Prof. James G. Needham who has supervised my work. As a student of the group himself, he is not only most ably fitted to guide the work, but his many manuscript notes and sketches of type specimens have been invaluable in making determinations. To him I also wish to extend grateful appreciation for innumerable suggestions and constant advice and encouragement. One of the species, *Dictyogenus ? phaleratus*, which appears for the first time in this paper, I am designating new species Needham, since the description is a quotation of Prof. Needham's manuscript.

Key to the Pteronarcinae and Perlodini

a. Reticulate venation extending in the fore-wing from costa through the anal veins ..... **Pteronarcinae**

b. Size large (one and one-half to two and one-half inches); thirteen pairs of tracheal gills ..... **Pteronarcys**

bb. Size small (about three-fourths inches); seventeen pairs of tracheal gills ..... **Pteronarcella**

aa. An apical network of cross-veins restricted to the anterior part of the wings, never extending in the fore-wing, posterior to the cubital veins. **Perlodini**

Subfamily PTERONARCINAE

Adults

The Pteronarcinae is one of the most distinct groups in the order Plecoptera. Although there is remarkable range of size in the individuals comprising the subfamily, they can be readily distinguished from all others by a reticulate venation reaching in the fore-wing from costa through the anal veins. In addition they are one of the few groups of the order which retain in the adult stage the rudiments of the tracheal gills. But the form of the gills, which are tufts of fine filaments, and their position, which is on the basal abdominal segments as well as on the venter of the thorax, is peculiar to them.

Nymphs

The nymphs of this sub-family are perhaps more distinct than the adults. Their bodies are much more cylindrical than those of any of the other members of the group and their coloration is striking. They are a uniform chocolate brown with conspicuous tufts of bushy, white, tracheal gills on the venter.

PTERONARCYS Newman

1838. *Pteronarcys* Newman, Ent. Mag., 5: 175.
1842. *Pteronarcys* Pictet, Perlides, p. 125.
1842. *Pteronarcys* Rambur, Hist. Nat. Ins. Neur., p. 449.
1861. *Pteronarcys* Hagen, Syn. Neur. N. A., p. 14.
1876. *Pteronarcys* Provancher, Le Nat. Can., 8: 188.
1877. *Pteronarcys* Hagen, Stett. Ent. Zeit., 38: 477.
1883. *Pteronarcys* Provancher, Pet. Faun. Can. Néurop., p. 67.
1906. *Pteronarcys* Banks, Proc. Ent. Soc. Wash., 8: 8.
1907. *Pteronarcys* Klapálek, Bull. internat. Acad. Sci. Bohême, 12, page 1 of reprint.

Adult

This genus contains the largest stone-flies of the entire order. They are dark brown insects with strong, elongated bodies; rather triangular heads; long, slender antennae; short, stout setae; and large wings, heavily net-veined (fig. 9).

Dark fuscous, with varied markings of paler colors, rufous, orange and yellow. Head with prominent rounded eyes; three ocelli forming an equilateral triangle; outside the lateral ocelli conspicuous round spots of a paler color, or dark and shining; supra-antennal plate well developed; antennae long, and tapering.

Prothorax wider than long, a little broader posteriorly, sides and front about straight, hind margin convex, angles sharp, a more or less prominent median yellow line, embossed markings on the disc. The distal end of the femur with a triangular notch on the inner surface; the segments of the tarsi of unequal length, the first segment twice as long as the second, which is the shortest, and the third a little longer than one plus two. The remains of thirteen pairs of tufted gills carried over from those of the nymph, but small, shrivelled and inconspicuous. Wings large, somewhat clouded on the veins, venation reticulate.

Abdomen cylindric, setae dark brown, paler at base. The instability of the color markings in this genus is so great as to

make them of little value in identification, but the structural modifications in genitalia serve as excellent specific characters. A few are generic; in the male, the tenth tergite is bifid (fig. 1), the supra-anal plate is remarkably modified, it is either produced and curved ventralward as a sperm-conveyer (fig. 1 Sup. A. P.), or it is an erect, probe-like organ (fig. 12). In the female the tenth tergite is entire, narrow below, and above produced into a triangular process; the supra-anal plate is a fleshy lobe attached to the ventral surface of the tenth dorsal segment (fig. 2 Sup. A. P.) and the sub-anal plates are triangular (fig. 2 Sub. A. P.).

We have representatives of all the North American species. Some species are represented by pinned specimens only, others by alcoholics as well. Wherever possible the latter are used for structural characters, and the dry specimens for color markings.

Nymph

Large ($1\frac{1}{4}$ in.), stout-bodied, concolorous nymphs with smooth bodies; long, slender antennae; short, stout, tapering setae; easily distinguished from all other stone-fly nymphs (except those of *Pteronarcella*, a genus of much smaller individuals) by the presence of tracheal gills on the basal segments of the abdomen.

Dark brown, head narrower than the prothorax, and slightly covered by its front margin. Three small ocelli forming an equilateral triangle; the distance from the lateral ocelli to the inner margin of the eyes equal to the distance between the ocelli. On either side of the ocellar triangle a round, rufous spot, a smaller and less conspicuous one anterior to it, a rufous V-shaped mark opening forward with its base in the median ocellus. The occipital margin with reticulate corrugations. Antennae long and tapering, well developed supra-antennal plates.

Prothorax about twice as wide as long; its sides flaring, the four angles produced. The three thoracic segments obscurely marked with rufous on the disc. Legs, stout; the distal end of the femur triangularly notched on the inner surface; the segments of the tarsus of unequal length, the second segment the shortest, half as long as the first; the third, as long again as one and two taken together.

Abdomen cylindric, the tenth segment narrow below, prolonged above into a median, conical process; the supra-anal

plate a small fleshy lobe attached to the ventral surface of the tenth tergite (figs. 20 and 21 Sup. A. P.), sub-anal plates large, triangular (figs. 20 and 21 Sub. A. P.).

Tufts of filamentous tracheal gills grouped about the legs on the ventral side of the thorax, and beneath the abdomen; anterior to the front legs, three pairs of gills arranged transversely, encircling the neck like a collar, posterior to the same legs, four pairs; posterior to the middle legs, three pairs; posterior to the last pair of legs, three pairs, one on the metathorax and one pair on each of the first two abdominal segments (fig 27).

Biology and Morphology

1840. Gosse, Canadian Naturalist: 231, 232.
1844. Newport, Ann. Nat. Hist., 13: 21 to 25.
1851. Newport, Trans. Linn. Soc. London, 20: 433 to 452.
1873. Gerstaecker, Zur Morphologie die Orthoptera amphibiotica, pp. 60 to 74.
1877. Hagen, Stett. Ent. Zeit., 38: 477 to 489.
1883. Packard, Third Rept. U. S. Ent. Com., pp. 322 to 325.

Biological Notes

Adult. The genus *Pteronarcys* has attracted attention since 1844 when Newport discovered that the adult retained, in a more or less imperfect state, the tracheal gills of the nymph. Some of the early naturalists considered *Pteronarcys* a nocturnal insect. Barnston saw *Pt. regalis* abroad only at dewfall, or in the night, and he observed it "constantly dipping to the surface of the water." Doubleday captured it chiefly "on wet evenings," by day he saw it hidden in crevices of rocks that were constantly wetted by the spray of falling water or under rocks, and in other damp places. Gosse found *Pt. proteus* at the Magog River in great numbers hanging to the rocky sides wet by the spray from the water-fall, or concealed in crevices of the rocks.

Newport interpreted this nocturnal habit as evidence of aquatic respiration in the adult. He says,

"They shun the open day, during which they remain secluded beneath stones or in damp places, where the air is charged with moisture. They come abroad at night, and are constantly in the neighborhood of streams and rivers, in which localities also the air is saturated with moisture. Under either of these circumstances the branchiae may be sufficient for all purposes of aeration."

In commenting on Barnston's observation of the adults dipping to the surface of the water, he suggested that the insect might be diving in search of food, or the female descending below the surface to deposit her eggs.

In 1873, Gerstaecker pointed out that Newport would have seen the fallacy of all such hypotheses had he observed any of the adults of the usual type, without gills, because they all have the same habit of staying in the region of streams and avoiding sunlight. As for dipping to the surface of the water, it could not be for the purpose of getting food, because, as Pictet noted, the reduction in the mandibles of adult stone-flies indicates that no nourishment is taken in that stage, but the explanation lies in the fact that the females dip to the water to lay their eggs. Gerstaecker, and a few years later Hagen, came to the conclusion which we still hold, that the tracheal gills of the adult are not essential for its existence, they are simply carried over from the nymphal stage, that the adults have the usual aerial method of respiration, being provided with spiracles as well as tracheal gills.

Hagen made some further observations on this genus, especially on the mating habits. By keeping a few adults of *Pt. dorsata* (*regalis*) confined in a large dish he discovered that mating occurred frequently, lasting each time from a quarter to half an hour. The male rested on the female grasping her wings with his feet, then bending the end of the abdomen under that of the female and using the dorsal appendages (that is, the two lobes of the bifid tenth tergite) to open up the genital passage, he quickly brought the penis forward into the vagina. The penis being separated from the opening of the sperm duct by the anus, functioned as a sperm-conveyer. Actual egg-laying was not witnessed, but masses of yellow-green eggs were found on the grass or in the water in the bottom of the dish. In two or three days the egg showed segmentation, but the water was evidently too warm for development to continue.

Nymph. There are scarcely any biological data on the nymph. Barnston observed that it constantly resided in the water "at the botton of streams and rivers." I have always found it clinging to the under side of stones in the most rapid parts of streams.

Morphological Notes

Adults. The interest which centered about the biology of *Pteronarcys* was aroused by the discovery of tracheal gills in the adult. Newport first described them in 1844. His paper contains a detailed discussion of their position and structure. Seven years later he published again on the anatomy of *Pteronarcys.* The article contains a more complete discussion of the gills, notes on the circulation of the blood, an account of the spiracles and the distribution of the trachea, and descriptions of the digestive, nervous and reproductive systems. A summary of his work is expressed in the following quotation:

"*Pteronarcys* retains the larva type of organization in all its structures, branchial organs of respiration, a capacious œsophagus and elongated alimentary canal, and more numerous and separated ganglia in its nerve cord."

Hagen added to, and in part corrected, Newport's work on the structure of the respiratory and reproductive systems.

Packard has contributed a paper on the sclerites of *Pt. californica.*

The most interesting morphological aspect of the genus *Pteronarcys* is found in the structure of the male genitalia. Any one who is familiar with Plecoptera knows what diversity of form the genital armature of the male presents; many groups are so highly specialized that several segments are modified in the formation of the copulatory organs, while in others there are no accessory appendages. *Pteronarcys* falls into the highly specialized group.

The remarkable modifications in *Pt. dorsata* (*regalis*) attracted Hagen's attention and in his paper on the mating habits of that species he discusses the structure in some detail. His manuscript contains further notes and sketches which Dr. Needham has copied and appended with comments of his own. The following description is drawn from both sources. It is the supra-anal plate which is of special interest. Here, in *Pt. dorsata* it is in the form of a sperm-conveyer. It is a median dorsal appendage (text-fig. B) entirely separated from the openings of the sperm ducts on the ninth segment by the anus which occurs on the eleventh. It consists essentially of three parts; an inner part (text-fig. B, I) which is buried in the musculature of the tip of

the abdomen and which is firmly bound by broad bands of muscle (text-fig. B, M) to the second part, a paired central piece called "the link" by Hagen (text-fig. B, L). These muscles move the third part, the free end (text-fig. B, F), in a vertical direction. Between the broad, flattened, distal ends ("para-anal plates" Hagen) (text-fig. B, P. A. P.) of the link opens the anus. The end of the free part of the sperm conveyer is an inverted chitinous bowl or cup (text-figs. B and C, C) containing within itself a membranous, eversible sac (text-fig. C, S) with two tendon attachments; one, probably a protractile tendon, attached at the rim of the cup (text-fig. C, P. T.), noted by Hagen, and the other, a retractor, at the base (text-fig. C, R. T.), first noticed by Dr. Needham.

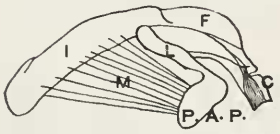

FIGURE B.—*Pteronarcys dorsata* Say. Supra-anal plate or sperm-conveyer, in left lateral view.

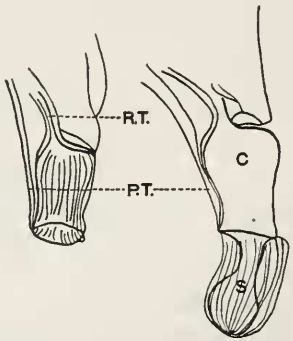

FIGURE C.—*Pteronarcys dorsata* Say. Tip of sperm-conveyer showing membranous sac within, and everted from cup. After Hagen's manuscript.

The structure presumably operates as follows; by the contraction of the muscles (text-fig. B, M.) the end of the penis is brought to the opening of the sperm ducts, then by a tightening of the protractile tendon the membranous sac is everted (text-fig. C, S) and with the suction accompanying its inversion, brought about by the retractile tendon, a sperm mass is drawn into the cup. This filling of the cup supposedly precedes copulation. Then in the same manner by eversion of the sac, the spermatozoa are probably transferred in copulation into the vagina of the female.

In *Pt. nobilis* the structure is practically identical with this in *Pt. dorsata*. *Pt. californica* and *Pt. princeps* are built on the same general plan. The inner part of the sperm-conveyer is much longer (text-fig. D, I), the free part more complicated (text-fig. D, F) and the cup (text-fig. D, C) smaller, but the filling of the sperm cup probably takes place as in *Pt. dorsata*. No tendons are conspicuous in *Pt. californica* or *Pt. princeps*.

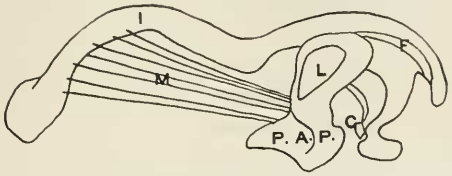

FIGURE D.—*Pteronarcys princeps* Banks. Supra-anal plate or sperm-conveyer, in left lateral view.

Pt. proteus and *Pt. biloba* represent another type of genitalia. Superficially the supra-anal plate appears to be totally different from that of the other group, but closer examination shows it to be made up of the same fundamental parts although somewhat modified in form and position. The inner part (fig. 11, I) is much the same aside from being a trifle more slender; the free end (fig. 11, F) is a direct prolongation of the inner part; it is a dorsally flexed, chitinous rod somewhat flattened anterio-posteriorly. In pinned specimens the rod appears to be entirely chitinized but in well preserved alcoholics the posterior surface is covered by a thin, fleshy pad. Surrounding the free end posteriorly and laterally there is a pair of chitinized plates articulated to the median portion (fig. 11, P. G. P.). Their point of attachment marks the boundary between the inner and free parts. Just dorsal to the place of articulation there is a pair of thin, chitinous triangular processes which I have called lateral braces (fig. 11, L. B.). Bands of muscle (fig. 11, M) connect the lateral plates with the inner part. The paired condition of these lateral plates, the presence of the muscle binding them to the inner part, and the position of their point of attachment to the median portion, seem to indicate that they are homologous with Hagen's "link" and "para-anals" in the *Pt. dorsata* type. They no longer lie vertically but have shifted to a horizontal position, the anus

opening ventral to them instead of between them. Thus Hagen's term, "para-anals," for the distal portions is not applicable here. Consequently I have termed the entire plates para-genitals.

A change of function has presumably accompanied the change in form of the free end of the supra-anal. It seems rather likely that it may be used as a probe-like organ in opening up the genital passage of the female. Since the supra-anal plate is apparently entirely accessory, the placing of the spermatazoa into the body of the female must take place in another way, probably by means of a true penis—one directly connected with the sperm ducts. Such a penis has been observed in *Perla immarginata*.[1] Here it is a soft, fleshy, contractile organ entirely concealed within the body except at the time of copulation, when it is protruded from the posterior border of the ninth sternite. The same kind has been found in *Isogenus frontalis* and *Perla decipiens*, and is undoubtedly the more common, and more primitive structure for the transference of spermatozoa in stone-flies.

Keys to Species of Pteronarcys Newman

Adults

Males

a. The ninth ventral segment elongate, with a notched tip, the tenth tergite bifid and its two lobes elongate, appendage-like.

b. Tips of the notch at apex of the ninth sternite straight or curved ventralward.

c. Tips of the notch at apex of the ninth sternite straight. Tips of the tenth tergite strongly bent upward, emarginate on opposed inner edges. . . . . **dorsata**

cc. Tips of the notch at apex of the ninth sternite curved ventralward. Tips of the tenth tergite only slightly curved dorsalward, inner margins entire . . . . . **nobilis**

aa. The ninth ventral segment truncate, the tenth tergite bifid with rounded lobes.

b. Sub-anal plates broadly triangular, supra-anal plate developed as a sperm-conveyer of remarkable form, curved ventralward.

c. Lobes of the tenth tergite, large, erect; sperm-conveyer flat above. **californica**

cc. Lobes of the tenth tergite, small, erect; sperm-conveyer, evenly rounded above . . . . . **princeps**

bb. Sub-anal plates spoon-shaped, supra-anal plate modified in the form of an erect probe.

[1] The Biology of Perla immarginata Say. L. W. Smith, Annals Ent. Soc. Amer., 6: 1913.

c. A narrow cleft between the lobes of the tenth tergite, large, oval horny areas on either side; on the ninth tergite a median rounded projection pointing anteriorly ..... **proteus**
cc. A wide cleft between the lobes of the tenth tergite; small oval areas on either side; no projection on the ninth tergite ..... **biloba**

Females

a. Eighth ventral segment without conspicuous median processes or teeth.
b. Posterior margin straight (or nearly so) or triangularly produced.
c. Posterior margin straight (or nearly so) with or without a small incision.
d. Without any incision ..... **dorsata**
dd. With a small rectangular incision ..... **nobilis**
cc. Posterior margin triangularly produced ..... **comstocki**
aa. Eighth ventral segment with a conspicuous pair of tooth- or spine-like processes.
b. With a pair of broad tooth-like or somewhat triangular processes.
c. The entire segment not modified in the formation of the processes.
d. Processes arise before the posterior margin of the segment.
e. Processes about as long as wide at base, inner margins straight, outer oblique; distance between the processes at their base, less than their breadth at base ..... **californica**
ee. Processes considerably longer than broad; inner margins straight or slightly concave, outer, oblique or a trifle convex; distance between processes at base, about equal to their breadth at base .... **princeps**
cc. The entire segment modified in the formation of the processes. Entire segment cleft, anterior part of each half prolonged into a process with inner margin concave and outer convex. Processes reach nearly across segment nine ..... **biloba**
bb. With a pair of median spine-like processes.
c. Processes arise in posterior half of segment, extend half way across segment nine ..... **proteus**

Nymphs

a. No lateral, apical hooks on abdominal segments. Supra-antennal plate blunt or ending in sharp tooth, and angles of prothorax produced laterally.
c. Supra-antennal plate blunt, and lateral prothoracic teeth short. **dorsata**
cc. Supra-antennal plate ending in a sharp tooth and lateral prothoracic teeth long ..... **californica**
aa. Lateral, apical hooks on abdominal segments, one to eight. Hooks close to body or standing well out from it.
b. Hooks close to body, inconspicuous on segments seven and eight. **proteus**
bb. Hooks well out from body, those on the seventh and eighth segments as conspicuous as the preceding ones ..... **biloba**

Pteronarcys dorsata (Say)

Adult

1823. *Sialis dorsata* Say, West. Quart. Rept., 2: 164.
1859. *Sialis dorsata* Say (*Perla* Geoffr., Say M. S. correction), Le Conte Ed., 1: 174.
1861. *Perla dorsata*, Hagen, Syn. Neur. N. A., p. 20.
1892. ?*Pteronarcys dorsata* Banks, Trans. Am. Ent. Soc., 19: 341.
1876. *Pteronarcys rectus* Provancher, Le Nat. Can., 8: 189.
1877. *Pteronarcys rectus* Hagen, Stett. Ent. Zeit., 38: 481.
1878. *Pteronarcys rectus* Provancher, Le Nat. Can., 10: 125.
1883. *Pteronarcys rectus* Provancher, Pet. Faun. Can. Néurop., p. 68.
1838. *Pteronarcys regalis* Newman, Ent. Mag., 5: 176.
1839. *Pteronarcys regalis* Newman, Mag. Nat. Hist., 3: 34.
1841. *Pteronarcys regalis* Pictet, Perlides, p. 134.
1851. *Pteronarcys regalis* Newport, Trans. Linn. Soc., 20: 425.
1861. *Pteronarcys regalis* Hagen, Syn. Neur. N. A., p. 15.
1873. *Pteronarcys regalis* Hagen, Proc. Bost. Soc. N. H., 15: 286.
1876. *Pteronarcys regalis* Provancher, Le Nat. Can., 8: 189.
1883. *Pteronarcys regalis* Provancher, Pet. Faun. Can. Néurop., p. 69.
1904. *Pteronarcys regalis* Banks, Proc. Ent. Soc. Wash., 6: 204.
1907. *Pteronarcys regalis* Klapálek, Bull. Internat. Acad. Sci. Bohême, 12, page 5 of reprint.
1876. *Pteronarcys flavicornis* Provancher, Le Nat. Can., 8: 191.
1877. *Pteronarcys flavicornis* Hagen, Stett. Ent. Zeit., 38: 481.
1878. *Pteronarcys flavicornis* Provancher, Le Nat. Can., 10: 125.
1883. *Pteronarcys flavicornis* Provancher, Pet. Faun. Can. Néurop., p. 70.
1841. *Kollaria insignis* Pictet, Perlides, p. 123.
1861. *Pteronarcys insignis* Hagen, Syn. Neur. N. A., p. 16.
1873. *Pteronarcys insignis* Hagen, Proc. Bost. Soc. N. H., 15: 287.
1877. *Pteronarcys insignis* Hagen, Stett. Ent. Zeit., 38: 481.
1873. *Pteronarcys frigida* Gerstaecker, Zur Morphologie der Orthoptera amphibiotica, p. 65.
1877. *Pteronarcys frigida* Hagen, Stett. Ent. Zeit., 38: 481.

Nymph

1851. *Pteronarcys regalis* Newport, Trans. Linn. Soc. London, 20: 428.
1873. *Pteronarcys regalis* Hagen, Proc. Bost. Soc. N. H., 5: 285.

Distribution.—Labrador; N. Red River; Saskatchewan River; Mackenzie and Slave Rivers; St. Martin's Falls, Albany River, Hudson's Bay; Michipicoten Island, Lake Superior; Maine; Massachusetts; Sandhill River, Minnesota; White Pigeon and Otter Rivers, Michigan; Elkhart, Indiana; Ungava Bay, Hudson Bay Territory; New York; Ohio River; Pennsylvania; District of Columbia.

Adult

♂.—Length to tip of wings, 40 to 47 mm.; length of antennae, 22 to 25 mm.; length of setae, 10 to 13 mm.; expanse of wings, 70 to 80 mm.

♀.—Length to tip of wings, 50 to 60 mm.; length of antennae, 22 to 26 mm.; length of setae, 12 to 15 mm.; expanse of wings, 86 to 106 mm.

The largest species in the genus; body dark fuscous, varied with paler markings. Head as broad as prothorax; labrum pale; a round, glossy spot either side of the ocellar triangle; supra-antennal plate widest in middle, forming a rounded angle.

Prothorax slightly widened posteriorly; front margin and sides, straight; posterior border convex; angles sharply produced; a median yellow line broader at the ends, interrupted in the middle by darker markings extending across the disc. Trochanters yellowish, knees yellow in some specimens. Wings greyish hyaline with blackish veins, somewhat clouded.

Abdomen pale yellow on the venter, posterior margins of the tergites paler.

Male. The ninth ventral segment, elongated toward the setae, with a terminal notch broadly open, the sides of the notch straight. The tenth segment covered below by the ninth; bifid above, its two lobes elongate and appendage-like, the opposed edges emarginate in the apical half, the tips rounded and strongly bent upwards. The sub-anal plates with long, straight, finger-like prolongations, parallel with, and extending beyond, the tips of the ninth ventral segment. The supra-anal plate modified as a sperm-conveyer; above it appears as a narrow trough, between the tips of the prolongations of the ninth ventral segment it curves ventralward and ends in an inverted cup or bowl-like structure (fig. 1).

Female. The eighth ventral segment truncate (fig. 2). Two small marginal triangular processes have been described in this species,[2] but as Hagen has pointed out[3] these are mere folds of membrane projecting from the posterior margin on the sides of the genital aperture, and are not always present.

Numerous specimens from the tributaries of the Ohio River, agreeing well with Say's description of *Pt. dorsata* and Newman's type specimen of *Pt. regalis*, have enabled me to reach a decision as to the identity of Say's long-lost species. Described above from many specimens, male and female, from Harrisburg, Pennsylvania; Elkhart, Indiana; and Ithaca, New York.

Nymph

Length of body, 33 mm.; length of antennae, 18 mm.; length of setae, 12 mm.

Dark brown, paler on the palpi and legs, and a broad median paler area along the entire length of the venter. Antennae uniform in color, of about 68 segments, the supra-antennal plate blunt with rounded corners.

Prothorax, broader behind, front margin and sides straight, hind margin convex, the corners produced laterally and arched upwards (fig. 17).

[2] Hagen, Proc. Bost. Soc. Nat. Hist., 15: 287.

[3] Stett. Ent. Zeit., 38, 1877: 480.

The last dorsal segment of the female narrow, elongated by the supra-anal plate, a long, straight, median, conical process (fig. 21). The supra-anal plate of the male broader and curved downward. The ninth sternite with a truncate prolongation extending over the tenth segment (fig. 20).

We have material from several places; two nymphs from White Pigeon River, Michigan (A. S. Pearse) IV, 13, 1909; two from the Otter River, Baraga County, Michigan; nymphs and exuviae from Elkhart, Indiana, IV, 1902; and exuviae from Ungava Bay, Hudson Bay Territory (L. M. Turner), and from Harrisburg, Pennsylvania.

Pteronarcys nobilis Hagen

Adult

1861. *Pteronarcys nobilis* Hagen, Syn. Neur. N. A., p. 15.
1873. *Pteronarcys nobilis* Hagen, Proc. Bost. Soc. N. H., 15: 285.
1894. *Pteronarcys nobilis* Banks, Ent. News, 5: 178.
1907. *Pteronarcys nobilis* Klapálek, Bull. Internat. Acad. Sci. Bohême, 12, p. 4 of reprint.
1873. *Pteronarcys pictetii* Hagen, Proc. Bost. Soc. N. H., 15: 286.
1876. *Pteronarcys pictetii* Provancher, Le Nat. Can., 8: 191.
1883. *Pteronarcys pictetii* Provancher, Pet. Faun. Can. Néurop., p. 70.
1907. *Pteronarcys pictetii* Klapálek, Bull. Internat. Acad. Sci. Bohême, 12, p. 7 of reprint.
1841. *Pteronarcys proteus* Pictet, Perlides, p. 128.
?1842. *Pteronarcys proteus* Rambur, Hist. Nat. Ins. Neur., p. 449.

Distribution.—New York; Tennessee; Kansas; Georgia; Pennsylvania; Minnesota; Canada.

♂.—Length to tip of wings, 31 to 34 mm.; setae, 12 mm.; expanse of wings, 55 to 57 mm.

♀.—Length to tip of wings, 45 to 48 mm.; setae, 11 mm.; expanse of wings, 80 to 84 mm.

Dark fuscous above and on appendages, orange beneath. Head about as wide as prothorax; the spots outside the ocellar triangle dark fuscous or black; supra-antennal plate very narrow.

Prothorax a trifle broader posteriorly, sides straight, front margin slightly convex, hind margin decidedly arcuated, angles sharpened, a more or less conspicuous, median, yellow line, broader at the ends. Wings smoky with dark veins.

Abdomen with a broad orange band beneath, the tip frequently shiny black, the tergites spotted laterally on the posterior margins with orange or rufous.

Male. The ninth ventral segment elongate, ending in a broad notch, the sides of the notch straight; the tenth segment concealed below by the ninth, bifid above, its two lobes, elongate and appendage-like, a little shorter than

those of *Pt. dorsata*, the inner edges not emarginate as in *Pt. dorsata*, and the tips only slightly curved upward. The sub-anal plates with long finger-like prolongations parallel with the tips of the ninth ventral segment, and not extending beyond them as in *Pt. dorsata*. The supra-anal plate produced and modified as a sperm-conveyer; above it appears as a narrow trough, between the tips of the prolongations of the sub-anal plates it turns ventralward and ends in a structure similar to an inverted cup (fig. 3).

Female. The eighth ventral segment not truncate as described by Hagen, but slightly produced with a median rectangular notch in the tip (♀ *Pt. pictetii* Hagen) (fig. 4).

This species is represented in our collection by nine males; two from Atlanta, Georgia, V, 1, 1908; one from Nashville, Tennessee, IV, 15, 1901; three from St. Paul, Minnesota; one (alcoholic) from New York, VII, 3, 1897; and four females; two from Nashville, Tennessee, IV, 15, 1901, one from St. Paul, Minnesota, and one from Missouri. The type specimen of this species is in the Museum of Comparative Zoology, Cambridge, Mass.

Two instances of occurrence in the same locality of the ♂ *Pt. nobilis* Hagen and the ♀ *Pt. pictetii* Hagen, and the striking similiarity in the coloration of the two, have led to the decision that they represent a single species. The possible synonomy of the two has already been suggested by Klapálek.[4]

Nymph unknown.

Pteronarcys californica Newport

Adult

1851. *Pteronarcys californica* Newport, Trans. Linn. Soc. London, 20: 450.
1861. *Pteronarcys californica* Hagen, Syn. Neur. N. A., p. 16.
1873. *Pteronarcys californica* Hagen, Proc. Bost. Soc. N. H., 15: 283.
1873. *Pteronarcys californica* Hagen, Geol. Surv. of Colorado, p. 573.
1883. *Pteronarcys californica* Packard, Third Rept. U. S. Ent. Com., p. 322.
1907. *Pteronarcys californica* Banks, Can. Ent., 39: 327.
1907. *Pteronarcys californica* Klapálek, Bull. Internat. Acad. Sci. Bohême, 12, p. 11 of reprint.

Nymph

1873. *Pteronarcys californica* Hagen, Proc. Bost. Soc. N. H., 5: 284.

Distribution.—Ogden River, Utah; Washington Territory between Rocky and Cascade Mountains; Platte Canyon, Colorado; Lake Winnipeg; Powder River, Colorado; Vancouver; Pecos, New Mexico; California.

[4] Loc. cit. p. 7.

Adult

♂.—Length to tip of wings, 33 to 40 mm.; expanse of wings, 58 to 66 mm.

♀.—Length to tip of wings, 41 to 46 mm.; expanse of wings, 72 to 84 mm.

Head and thorax dark fuscous above, paler beneath, abdomen paler. Head as wide as prothorax, spots beyond the lateral ocelli, rufous; supra-antennal plate ending in a sharp tooth. Pronotum nearly as long as broad, anterior border and sides straight, posterior border convex, angles not conspicuously sharpened, median reddish-yellow line broader at ends. Legs dark fuscous.

Male. The ninth ventral segment not produced, with a hollowed scar each side, the middle area broader at the base than the tip. The tenth segment very narrow below; bifid above, the lobes, erect, transverse knobs. The sub-anal plates broadly triangular. The supra-anal plate modified as a sperm-conveyer, above it appears as a flat trough, cleft at the tip, on the ventral side it is elongated before the cleft, and ends in a sperm cup (fig. 5).

Female. The eighth ventral segment produced before the tip into two flat, tooth-like, or somewhat triangular, processes, oblique outside, and straight inside, reaching half way across the ninth segment, separated by a rounded notch (fig. 6).

We have six males; two from Colorado, VI, 30, 1904, and four (alcoholic) with no locality labels; and six females, two from Colorado, 1904; one from Los Pinos, Colorado, one from California and two (one alcoholic) without locality labels.

Nymph

Length of body, 34 mm.; length of antennae, 17 mm.; length of setae, 8 mm.

Antennae unicolorous, of about seventy segments; the supra-antennal plate ending in a sharp tooth. Prothorax broader posteriorly; its front and hind margins convex, each angle produced laterally in a long, up-curved tooth, making the sides appear concave (fig. 19).

In the male the supra-anal plate, less tapering, and bent ventralward (fig. 22). In the female the tenth tergite narrow, prolonged in a sharp, median, conical process, the supra-anal plate (fig. 23). Setae of uniform coloration, stout, a little over a fourth the length of the body.

Described from cast skins in which no color pattern was visible.

Exuviae from Platte Canyon, Colorado; Powder River, Colorado; VI, 15, 1883; Pecos, New Mexico; VI, 7, 1903; and immature nymphs from Ogden, Utah.

Pteronarcys princeps Banks

Adult

1907. *Pteronarcys princeps* Banks, Can. Ent., 39: 327.

1907. *Pteronarcys fumipennis* Klapálek, Bull. Internat. Acad. Sci. Bohême, 12, p. 11 of reprint.

Distribution.—Mission, British Columbia; San Francisco, California; Dilley, Oregon; Washington.

♂.—Length to tip of wings, 36 mm.; length of antennae, 21 mm.; length of setae, 7 mm.; expanse of wings, 68 mm.

♀.—Length to tip of wings, 47 mm.; expanse of wings, 83 mm.

Very dark brown, or black, much darker than any of the other species, paler around bases of appendages. Head about the width of prothorax; spots outside the ocellar triangle dark; supra-antennal plate narrow, posterior angle slightly produced.

Prothorax wider than long, front margin and sides nearly straight, posterior border convex, angles sharp; median reddish-yellow line narrow, more or less interrupted in the middle. Venter of the thorax varied with paler. Legs dull blackish-brown; wings very dark, clouded, veins blackish-brown.

Abdomen paler brown, blackish on the pleura.

Male. The genitalia very similar to *Pt. californica*, the ninth ventral segment with hollowed scars on either side, the middle area broader at the base than tip. The tenth segment concealed below by the ninth, bifid above, the lobes, erect, transverse knobs as in *Pt. californica*, but smaller. The sub-anal plates broadly triangular. The supra-anal plate modified as a sperm-conveyer, above it appears as a trough evenly rounded, cleft at the tip. Before the cleft it is prolonged ventralward, ending in a sperm-cup (fig. 7).

Female. The entire eighth segment modified in the formation of two large, flat, triangular processes, the cleft between them reaching to the posterior margin of the segment, the opposed margins straight (in one specimen they appear slightly concave), outer margins oblique, or a trifle convex, the processes reaching across segment nine (fig. 8).

We have two males, one (alcoholic) from Dilley, Oregon, and one (alcoholic) from California; three females from California. Hagen's manuscript species, *Pt. infuscata* ♀, and *Pt. nigra* ♂, apparently belong here also. Professor Needham examined the type specimens, and placed them together under the name *Pt. nigra*. They were apparently taken together, both bearing the same label, San Francisco, and they agree well in general coloration. His notes and sketches from the types indicate their synonomy with *Pt. princeps*.

Type specimen of this species in the Bank's collection in the Museum of Comparative Zoology, at Cambridge, Massachusetts.

Nymph unknown.

Pteronarcys proteus Newman

Adult

1838. *Pteronarcys proteus* Newman, Ent. Mag., 5: 177.
1839. *Pteronarcys proteus* Newman, Mag. Nat. Hist., 3: 34.
1861. *Pteronarcys proteus* Hagen, Syn. Neur. N. A., p. 14.
1873. *Pteronarcys proteus* Hagen, Proc. Bost. Soc. N. H., 15: 281.
1894. *Pteronarcys proteus* Brongniart, Recherches sur l'Hist. des Insect. Foss., p. 186.
1907. *Pteronarcys proteus* Klapálek, Bull. Internat. Acad. Sci. Bohême, 12, p. 7 of reprint.
1906. *Pteronarcys spinosa* Banks, Proc. Ent. Soc. Wash., 8: 8.
1907. *Pteronarcys spinosa* Klapálek, Bull. Internat. Acad. Sci. Bohême. 12, p. 13 of reprint.

Nymph

1873. *Pteronarcys proteus* Hagen, Proc. Bost. Soc. N. H., 15: 283.

Distribution.—Trenton Falls and Ithaca, New York; Mackenzie River District; North Red River; Hoosac Mountains, Massachusetts; Oregon; Vermont, and California?

Adult

♂.—Length to tip of wings, 33 mm.; length of antennae, 17 mm.; length of setae, 7 mm.; expanse of wings, 56 mm.

♀.—Length to tip of wings, 40 mm.; length of antennae, 20 mm.; length of setae, 7 mm.; expanse of wings, 70 mm.

Dark fuscous; head a little narrower than prothorax; spots outside the ocellar triangle, rufous. Prothorax slightly widened posteriorly, sides and front border straight, hind margin convex, angles, right but not sharpened; a narrow, more or less obsolete, median, rufous line. Venter of thorax varied with testaceous.

Male. The ninth ventral segment not produced, the sides with hollowed scars, the middle area narrow, sides almost straight; the ninth tergite with a horny, rounded projection pointing anteriorly. The tenth segment very narrow below, nearly covered by the ninth; bifid above with rounded lobes, on the opposed margins, close to the posterior border of the segment, prominent, flat, oval, horny areas. The sub-anal plates spoon-shaped, clasping the base of the supra-anal plate, which is modified into a slender, erect, probe-like organ (fig. 12).

Female. The eighth ventral segment of this species is not triangularly produced as Newman described it, but it possesses a median sub-marginal pair of spine-like processes extending half way across the ninth segment (fig. 13). Bred specimens have led to the finding of the true female of this species.

Three males (one alcoholic) from Ithaca, New York, and four females, one from Hoosac Mountains, Massachusetts, and three (two alcoholic) from Ithaca. Both males and females of this

species were bred in May 15 to 20, 1899, by Mr. G. H. Jensen; and in May 14 to 21, 1911, by L. W. Smith.

The type specimen of this species is in the British Museum, London.

Nymph

Length of body 32 mm.; length of antennae, 15 mm.; length of setae, 6 mm.

Color dark brown, paler beneath and on all appendages. Antennae of about sixty-five segments; the middle third paler, in exuviae this area shows as a band of white; the supra-antennal plate, blunt with sharp corners.

Prothorax slightly widened posteriorly; its anterior margin and sides slightly arcuated, the posterior border decidedly convex; sides flaring, produced beyond the front and hind margins, forming conspicuous acute angles (fig. 16).

Segments one to eight of the abdomen with lateral apical hooks; the hooks close to the body, the posterior edges not more than half as long as the lateral edges, the hooks on segments seven and eight small and inconspicuous. The supra-anal plate alike in both sexes, a tapering projection of the last dorsal segment (figs. 24 and 25). Setae short, stout, banded with white in the apical half but the tip darker.

Numerous nymphs and exuviae of bred specimens. This species was bred in May 15 to 20, 1899, by Mr. G. H. Jensen, and in May 14 to 21, 1911, by myself.

Pteronarcys biloba Newman

Adult

1838. *Pteronarcys biloba* Newman, Ent. Mag., 5: 176.
1839. *Pteronarcys biloba* Newman, Mag. Nat. Hist., 3: 34.
1841. *Pteronarcys biloba* Pictet, Perlides, p. 135.
1861. *Pteronarcys biloba* Hagen, Syn. Neur. N. Am., p. 15.
1873. *Pteronarcys biloba* Hagen, Proc. Bost. Soc. N. H., 15: 284.
1907. *Pteronarcys biloba* Klapálek, Bull. Internat. Acad. Sci. Bohême, 12, p. 10 of reprint.
1876. *Pteronarcys bicarinatus* Provancher, Le Nat. Can., 8: 190.
1878. *Pteronarcys bicarinatus* Provancher, Le Nat. Can., 10: 125.
1883. *Pteronarcys bicarinatus* Provancher, Pet. Faun. Can., Néurop., p. 69.

Distribution.—Trenton Falls and Ithaca, New York; St. Martin's Falls, Albany River, Hudson's Bay; Black Mountains, North Carolina; Virginia.

♀.—Length to tip of wings, 46 mm.; expanse of wings, 84 mm.

♂.—Length to tip of wings, 34 mm.; expanse of wings, 55 mm.

Dark fuscous above and below,.the head without paler markings except for rufous spots outside the lateral ocelli. Prothorax a little broader posteriorly, front border and sides straight, hind margin slightly arcuated, angles not sharp; a narrow, rufous median line. Legs dark brown, knees paler.

Male. The ninth ventral segment slightly produced, forming a short subgenital plate, the posterior border somewhat thickened; two longitudinal carinae divide the plate into three fields, the middle one narrower at tip than base, the lateral areas deeply hollowed. The tenth segment very narrow below; bifid above, a wide cleft separating the two rounded lobes, each with a small, oval, horny area at the base. The sub-anal plates spoon-shaped and clasping the base of the supra-anal plate, which is modified to form a short, stout, erect probe (fig. 14).

Female. The entire eighth sternite involved in the formation of the vulvar lamina; a deep median cleft divides the segment into two flat, obtuse processes, whose opposed edges are straight at the base, concave in the apical half, and the outer edges, convex (fig. 10).

Two males, one from Black Mountains, North Carolina, and the other (alcoholic) from Ithaca, New York, May, 1891, and one female without locality data.

Newman's type specimen is in the British Museum, London.

Nymph

I am placing this undescribed nymph here tentatively since it was found in the same general region in which the adult occurs, and since it is similar to the nymph of *Pt. proteus* Newman,—the adults of the two species being closely allied. The general color is perhaps a little darker than *Pt. proteus*, and the posterior angles of the prothorax may be a little more produced (fig. 18). The chief difference, and the only one recognizable without the two for comparison, is in the lateral hooks on the abdomen. In *Pt. biloba* they stand well out from the body, the posterior and lateral edges being about equal in length, and the hooks on the seventh and eighth segments are as prominent as those on the preceding segments (fig. 26). In *Pt. proteus* the hooks are close to the body, and those on segments seven and eight are small and inconspicuous.

A number of immature female specimens from Virginia (MacDonald) are in hand.

Pteronarcys comstocki new species

1838. ♀ *Pteronarcys proteus* Newman, Ent. Mag., 5: 177.
1839. ♀ *Pteronarcys proteus* Newman, Mag. Nat. Hist., 3: 34.
1873. ♀ *Pteronarcys proteus* Hagen, Proc. Bost. Soc. N. H., 15: 281.
1907. ♀ *Pteronarcys proteus* Klapálek, Bull. Internat. Acad. Sci. Bohême, 12, p. 7 of reprint.

Distribution.—Trenton Falls and Wilmurt, New York.

The female formerly called *Pt. proteus* is here renamed *Pt. comstocki.*

♀.—Length to tip of wings, 52 mm.; expanse of wings, 70 mm. (Newman's *Pt. proteus* type).

Head a little narrower than the prothorax. Prothorax slightly widened posteriorly; sides and front border straight; posterior margin convex; angles right; a light triangular spot on median anterior border. Venter of thorax varied with pale markings, posterior margin of the first seven sternites bordered with a narrow, pale band, the eighth, except for the tip, and ninth entirely light.

Female. Eighth ventral segment somewhat triangularly produced with a small, median, rectangular, apical notch. The incision has not been noted in previous descriptions, but since it is very inconspicuous, we do not regard it, at present, as a species distinct from that originally described under *Pt. proteus* (fig. 15).

Type.—A single pinned specimen in poor condition (faded, having once been in alcohol, and with broken wings), from Wilmurt, New York, (Comstock), in the entomological collection, at Cornell University, Ithaca, New York.

Male unknown.

Nymph unknown.

PTERONARCELLA Banks

1900. *Pteronarcella* Banks, Trans. Amer. Ent. Soc., 26: 242.

Adult

This is a western genus similar to *Pteronarcys*, but smaller. There are other characters as distinctive as the size; the venation is reticulate (fig. 58) but the cross-veins are fewer and more regular, in the fore-wing the cell between the basal part of radius and media is without cross-veins, cubitus has no accessory veins; the supra-antennal plate is not well developed; the angles of the prothorax are not produced; and the genitalia are of quite a different character.

Color, dark brown, varied with darker and lighter markings. Head as broad as prothorax; ocelli well developed, forming an equilateral triangle; a blackish rectangular spot across the ocellar triangle, on either side beyond the blackish area a pale, flattened tubercle, anterior to it, the lateral margin carinated; antennae slender.

Prothorax about square, perhaps a little wider than long, angles rounded, not produced, the disc corrugated; the three thoracic segments very dark above, paler beneath. Wings very much reduced in size in the males of some species, veins brown. The inner surface of the femur with a triangular groove, its base at the distal end, the segments of the tarsi of unequal length, the second the shortest, half as long as the first, the third as long as one and two taken together.

Abdomen cylindric, paler beneath. Setae long and slender, bases stout, the first five basal segments very short. Seventeen pairs of tracheal gills, small and inconspicuous, carried over from the nymph.

Male. The ninth segment very much elongated above and below, entirely concealing the tenth segment and the supra-anal plate (fig. 28); sub-anal plates conspicuous (fig. 28, Sub. A. P.).

Female. The tenth segment narrow below, triangularly produced above, the supra-anal plate a rounded fleshy lobe attached to the ventral surface of the tenth tergite; sub-anal plates triangular (fig. 29).

Nymph

Nymphs very similar to *Pteronarcys* but readily distinguished from them by their smaller size (when grown about three-fourths inch), and the presence of a pair of tracheal gills on the third segment of the abdomen, as well as a pair on each of the first two segments, as in *Pteronarcys*.

Color nearly uniform, brown. Head rather triangular, much narrower than the prothorax; three small ocelli forming an equilateral triangle; paler, inconspicuous markings on this disc, antennae slender, tapering, a little less than half the length of the body; supra-antennal plate narrow.

Prothorax considerably broader than long; sides, flaring, convex, angles well rounded, more or less obsolete embossed markings on the disc. Legs stout, the inner surface of the femur with a triangular groove, its base at the distal end; the segments of the tarsi of unequal length, the second is the shortest, and is half as long as the first, the third is twice as long as the first two taken together.

Abdomen cylindric, the tenth segment narrow below, prolonged above into a triangular process ending in a sharp spine (fig. 34); the supra-anal plate, a rounded fleshy lobe, attached to the ventral surface of the tenth dorsal segment (fig. 34 Sup. A. P.); the sub-anal plates, triangular, divergent at the tips (fig. 34 Sub. A. P.). Setae, slender, tapering, a little more than a third as long as the body.

Seventeen pairs of tufted tracheal gills on the ventral side of the thorax and the basal segments of the abdomen, arranged in the following manner, three pairs in the integument of the neck, forming a collar, one pair (much smaller) on the lateral anterior margin of the base of the front legs, four pairs arranged around the posterior margin of the same pair of legs, a single pair on the median anterior margin of the base of the second pair of legs, three pairs arranged around the posterior margin of the base of the third pair of legs, one pair (much smaller) on the lateral posterior margin of the same legs; three pairs, one on each of the first three abdominal segments (fig. 33).

Morphological Notes

The genus *Pteronarcella* is as yet so little known that the literature contains absolutely no biological and morphological data concerning it.

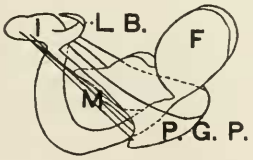

FIGURE E.—*Pteronarcella regularis* Hagen. Supra-anal plate in left lateral view.

Although the supra-anal plate of the male is normally completely hidden, it has been dissected out in *Pteronarcella regularis*. It is of considerable interest in establishing a further bond of kinship between this genus and *Pteronarcys*. It is through the *proteus* type of *Pteronarcys* that the relationship can be traced. The supra-anal plate consists of the same essential parts although decided differences in detail are very evident.

Among these are the considerably shortened inner end (fig. E, I) and the greater development of the lateral braces (fig. E, L. B.). In size the braces are not relatively larger than those in *Pt. proteus*, but they are much more heavily chitinized and consequently much stronger. It seems probable that the reduction of the inner end has necessitated some such lateral extension to strengthen the place of attachment of the supra-anal within the body. The relative position, attachment and muscular connection (fig. E, M) of the para-genital plates (fig. E, P. G. P.) is the same as in *Pt. proteus*. The free end (fig. E, F) is curiously modified at the extremity. It is made up of a pair of partially chitinized semi-elliptical plates, attached to each other at the posterior margins only, just ventral to the base of these hangs a pair of delicate heart-shaped membranous sacs. Just what the function of such a structure might be is puzzling. It is probably of accessory nature and here again the presence of a true penis on segment nine, connected with the sperm-ducts is assumed.

Keys to Species of Pteronarcella

Adults

Males

a. The dorso-lateral posterior margin of the second segment without a conspicuous rounded knob (knobs conspicuous only on segments four or five to nine), the ninth dorsal segment with a broad scoop, sub-anal plates dark brown . . . . . **regularis**

aa. The dorso-lateral posterior margin of the second segment with a conspicuous rounded knob (segments two to nine with prominent knobs), the ninth dorsal segment with a shallow, narrow scoop, subanal plate whitish. **torosa**

Females

a. The entire length of the eighth ventral segment involved in the formation of the vulvar lamina, and the median area of the posterior border produced. (The vulvar lamina with a trilobed tip or a single lobe.)

b. A single lobe with a more or less conspicuous notch in the tip. **regularis**

bb. A trilobed tip, the middle lobe the longest . . . . . **triloba**

aa. The posterior border only of the eighth ventral segment involved in the formation of the vulvar lamina, the median area not produced. (A rounded knob on either side of the median area, the part between the notches, a narrow lobe not reaching the border of the segment) . . . . . **badia**

Nymphs

a. With thick fringes on the femora and tibiae, and the filaments of the gills rather stout, erect ..... **"a"**
aa. Without thick fringes on the femora and tibiae, and the filaments of the gills, thread-like, long, slender ..... **torosa**

Pteronarcella regularis Hagen

Adult

1873. *Pteronarcys regularis* Hagen, Bull. Geol. Surv. of Col., p. 573.
1900. *Pteronarcella regularis* Banks, Trans. Amer. Ent. Soc., 26: 242.

Distribution.—Sierra Nevada; Selkirk Mountains, British Columbia; Wyoming; Colorado.

♂.—Long-winged,—length to tip of wings, 15 to 17 mm.; expanse of wings, 28 mm. Short-winged,—length to tip of abdomen, 12 mm.; expanse of wings, 18 mm.

♀.—Length to tip of wings, 19 mm.; length of antennae, 11 mm.; length of setae, 8 mm.; expanse of wings, 35 mm.

Dark brown, paler beneath. Head as broad as prothorax; lateral anterior margins carinated; a blackish spot through the ocelli, at the level of the anterior ocellus a lateral extension reaching the carinae, which are also blackish, a little before the posterior ocelli another lateral extension, in most cases less conspicuous than the anterior one and in some specimens entirely lacking; on either side between the lateral bands a prominent, pale yellow tubercle; usually a dark brown patch on either side on the occipital margin. The ventral aspect of the basal segments of the antennae often yellow.

Prothorax nearly square, the width a little greater than the length, sides straight, front and hind margins very slightly convex, angles rounded, a more or less conspicuous, median, yellow line, embossed markings on the disc. Tarsi pale beneath, very dark brown above, especially the second and third segments. Wings hyaline, veins strong, dark brown. Both long and short winged males in this species.

Abdomen cylindric, paler beneath, and in some specimens a tendency for a paler dorsum, sides dark.

Male. The dorso-lateral posterior margins of segments three to nine with rounded, hairy knobs—those on the third and fourth segments more or less small and inconspicuous, the others prominent. Segment nine greatly produced, the posterior border truncate, on the dorsum between the two lateral knobs a broad scoop-like prolongation pointing anteriorly. On the venter the middle area of segment nine, cut off by lateral carinae, the posterior border produced and evenly rounded. The tenth segment and the supra-anal plate completely hidden by the ninth segment. The sub-anal plates dark brown, with dorsal appendage-like processes curved anteriorly, their tips reaching the base of the "scoop" (fig. 28).

Female. The vulvar lamina almost as broad as the segment at the base, sides gradually sloping to a narrow rounded tip, produced beyond the posterior

border of the segment, tip more or less conspicuously notched, the middle area dark brown, chitinous, sides, pale, membranous. The lamina is not separate from the eighth segment, but is formed by deep lateral folds of the segment and its tip is continuous with the border of the segment (fig. 29).

Four males, one from Selkirk Mountains, British Columbia (Bradley), VIII, 13, 1905; one (short-winged) from Colorado, and two with no data, but probably from Colorado.

Eight females, two taken with the male in the Selkirk Mountains; one from Yellowstone Park, Wyoming; two from Manitou, Colorado, VI, 3, 1879 (Ill. State Lab. Collection) and three with no locality label (Acad. Nat. Sci. Phila.).

The type specimen of this species is in the Museum of Comparative Zoology, Cambridge, Mass.

Nymph unknown.

Pteronarcella badia Hagen

Adult

1873. *Pteronarcys badius* Hagen, Bull. Geol. Surv. of Col., p. 573.
1900. *Pteronarcella badia* Banks, Trans. Amer. Ent. Soc., 26: 242.

Distribution.—Bridger Basin, Wyoming; Cache Valley, Utah; Colorado Mountains.

♀.—Length to tip of wings, 19 mm.; expanse of wings, 34 mm.

Pale brown; anterior part of head yellowish above and below, palpi brown; occipital region brownish with paler irregular sculpturings; the lateral anterior margins carinated; a square black spot around the ocelli, just behind the anterior ocellus, lateral horns extending toward, but not reaching, the carinae; carinae blackish; conspicuous round yellow tubercle on either side posterior to the lateral horns.

Prothorax brownish, slightly broader than long, sides straight, anterior and posterior margins a trifle convex, front angles square but not sharp, hind angles rounded, a yellow spot on the middle of the anterior and posterior margins, not connected by a conspicuous line, coarse paler sculpturings on the disc. Meso- and metathorax dark brown, varied with paler on the venter. Tarsi considerably darker than the other segments of the legs.

Abdomen brown; paler beneath and on the dorso-lateral area of the last four or five segments; setae pale.

Female. The posterior margin of the eighth segment notched on either side of the mid-ventral line; the part between the notches chitinized, dark brown, a little produced, but not reaching the border of the segment (fig. 32).

One unlabelled specimen.

Hagen's type specimen is in the Museum of Comparative Zoology, Cambridge, Mass.

Male unknown.

Nymph unknown.

Pteronarcella torosa new species

Adult

Distribution.—Santa Fé, New Mexico.

♂.—Length of body, 16 mm.; length of antennae, 11 mm.; expanse of wings, 12 mm.

Pitch brown, paler beneath. Head a little broader than the prothorax, lateral anterior margins carinated, a square black spot across the ocelli; on either side of the ocellar triangle a conspicuous pale yellow tubercle; labrum pale yellow; carinae pale; a broad pale band along the inner margins of the compound eyes, antennae pale, darker toward the tip.

Prothorax dark brown, a little wider than long, sides straight, anterior and posterior margins a little convex; angles round; a small median pale spot on the anterior margin, a larger more prominent one on the posterior border, coarse pale sculpturings on the disc. Meso- and metathorax dark brown above, the entire thorax yellow beneath. Trochanters and coxae yellow. Wings very small, brownish, veins brown, venation greatly reduced.

Male. Abdomen cylindric, dark brown above, pale beneath. The first dorsal segment with a conspicuous median whitish spot. The dorso-lateral posterior margins of segments two to nine with prominent, hairy, rounded knobs. The posterior border of the ninth dorsal segment truncate; between the two knobs on this segment a rather shallow, narrow, scoop-like projection pointing anteriorly. The median ventral region of the ninth segment cut off by lateral carinae, its margin produced, evenly rounded. The tenth segment and the supra-anal plate entirely concealed by the ninth. The sub-anal plates pale yellow, with dorsal appendage-like projections pointing anteriorly, the tips reaching the base of the scoop (fig. 30).

Type specimen, a male from Sante Fé, New Mexico, (P. B. Powell), VI, 1, 1904, in the entomological collection at Cornell University, Ithaca, N. Y.

Female unknown.

Nymph

♂.—Length of body, 16 mm.; length of antennae, 7 mm.; length of setae, 5 mm.

♀.—Length of body, 23 mm.; length of antennae, 8 mm.; length of setae, 8 mm.

Chestnut-brown. Head considerably narrower than prothorax; ocelli blackish; a dark brown, rectangular spot extending through the ocellar triangle, beyond it on either side a pale round spot; palpi pale yellow; antennae light brown, of about forty-one segments, the supra-antennal plate narrow; the occipital margin with reticulate corrugations.

Prothorax nearly twice as broad as long, front margin straight, hind margin and sides convex, angles produced, well rounded; a slight indication of a narrow median yellow line, broadened at the ends; the disc with embossed markings (fig. 37). Legs paler than body, especially tibiae and tarsi.

Abdomen cylindric, three very fine lines extending the length of the abdomen on the dorsum, the basal segments paler on the venter. Setae pale brown. Filaments of the tracheal gills thread-like, long and slender.

Male. The tenth dorsal segment produced above in a short, straight spine, below at the base of the spine, a rounded prominence; the supra-anal plate a smaller fleshy lobe attached to the tenth segment below the rounded prominence (fig. 34).

Female. The eighth ventral segment with a median depression on the posterior border. The tenth segment narrow below, produced above in a conical process curved upward; the supra-anal plate a fleshy lobe attached to the ventral surface of the tenth tergite (fig. 35).

One male from Sante Fé, New Mexico, (P. B. Powell collector), VI, 1, 1904, and one exuvia taken at the same time, also an exuvia from Pecos, New Mexico, (Prof. T. D. A. Cockerell), VI, 1903. Three females, two from Sante Fé, and one from Pecos, and an exuvia from each place. All of these specimens are at Cornell University. The exuvia from Pecos, New Mexico, June, 1903, is the described specimen.

Pteronarcella triloba new species

Adult

♀.—Length to tip of wings, 17 mm.; expanse of wings, 33 mm.

Pale brown. Head as broad as prothorax, lateral anterior margins carinated, anterior part of head darker than posterior, a square black spot through the ocelli continued just behind the anterior ocellus in lateral horns reaching the carinae, carinae very dark brown; on either side posterior to lateral extensions of the black spot, a conspicuous pale yellow tubercle; paler areas around the inner margins of the compound eyes; occipital area corrugated. Antennae dark brown, paler at base.

Prothorax a little broader than long; sides, front and hind margins about straight, angles, rounded, a pale yellow median line, the disc sculptured. Meso- and metathorax dark brown, varied with paler on the venter. Tarsi darker than the other segments of the legs.

Abdomen pale above and below, darker toward the tip. Setae dark brown.

Female. The middle area of the eighth ventral segment dark brown, horny, narrower at the base than the tip; the tip three lobed, the middle lobe the longest, extending beyond the border of the segment, the lateral ones, not reaching beyond the border, but continuous with the lateral membranous margin (fig. 31).

One female in alcohol sent to Dr. Needham by C. P. Gillette, from Colorado. This is the type specimen. It is at Cornell University in the entomological collection.

Male unknown.

Nymph unknown.

Pteronarcella nymph—**"a"**

♀.—Length of the body, 19 mm.; length of antennae, 9 mm.; length of setae, 7 mm.

Blackish-brown with no conspicuous variation in color or markings except for the thick, white fringes of hair on the legs, and the white tracheal gills. Head very much narrower than the prothorax, ocelli inconspicuous; faint, round spots outside the ocellar triangle. Antennae slender, tapering, of about forty-five segments.

Prothorax almost twice as broad as long, front and hind margins straight; sides, flaring, convex; angles rounded (fig. 38). Legs with heavy fringes of long, white hairs along the outer edge of the femur and tibia.

Abdomen cylindric. Tracheal gills very conspicuous, each tuft composed of many rather stout, erect filaments.

Female. The posterior margin of the eighth ventral segment with a median depression; the tenth segment narrow below, produced above into a triangular process ending in a straight, sharp spine; the supra-anal plate, a fleshy lobe attached ventrally to the anterior part of the tenth dorsal segment (fig. 36).

Two female nymphs (alcoholic specimens), not quite mature, from Tyler Lake, Boulder, Colorado, III, 13, 1905. These nymphs are in the entomological collection at Cornell University.

For the present this nymph is left unnamed, since it may belong to one of the Colorado species, *Pteronarcella regularis* or *Pteronarcella badia*.

PERLODINI

A few years ago Klapálek separated off from the *Perlini*, the genera *Perlodes* Banks, *Isogenus* Newman and a small part of *Perla* Geoffroy, under the name *Perlodidae*. This family contains a number of genera, some made by revision of the old ones, while others are entirely new. He has used venation and genitalia as primary characters for classification. As formerly, in the genera *Perlodes* and *Isogenus*, the chief venational character is the apical network of cross-veins. Klapálek recognizes two groups, one in which "there is present a more or less irregular network of cross-veins in the tip between R, its sector, and the branches of the latter, sometimes even to M, and from its posterior branch to the posterior margin"; and another group in which "the network is lacking and there is a single cross-vein between R and Rs."

Under the tribe *Perlodini* I am including those genera of Klapálek's family *Perlodidae* which have an apical network of

cross-veins, that is those which have more than a single cross-vein between radius and the radial sector. In color these stone-flies are dark brown with markings of yellow; the head is relatively large; the eyes are hemispherical; there are present three small ocelli arranged in an isosceles triangle, the base of which is greater than the sides; the tubercles are more or less conspicuous; the antennae and palpi are slender. The prothorax is broader than long, a median yellow stripe is usually present and the lateral fields are embossed. Legs are rather long; the three segments of the tarsi are of unequal length, the third being the longest, and greater than the first two taken together, the second segment is the shortest, it is half as great as the first. The wings are often shortened, especially in the males. An apical network of cross-veins is always present, its extent and regularity differing in the various genera; the accessory branches of the first cubital vein have a decided anterior flexure; with the exception of *Dictyogenus? phaleratus*, in the fore-wing the first anal vein angled at the base, as it leaves the anal cell it runs forward to the second cubital vein, then it makes an abrupt posterior bend. Another useful venational character of generic importance in this tribe is the relation between the length of the inner inter-radial cell (1st R_1) and its base, measured to the point at which the arculus would meet radius if produced. Dr. Ris and Prof. Klapálek have used this character.

Some of the members of this tribe are gill-bearing. In dried specimens the gills are very difficult to detect on account of their shrunken condition and small size. In alcoholics they appear as delicate, white, fleshy, finger-like, blind sacs. Their number varies in different species but is constant within a single species. Other species are without gills.

In the males the ninth sternite is produced in a sub-genital plate; the tenth tergite is bifid in most genera (in all the genera that are known certainly to occur in this country); the sub-anal and supra-anal plates often modified as accessory copulatory organs.

In the females the usual vulvar lamina is present. Klapálek has used its form as a generic character, but his groupings contain such a wide range that they are not especially valuable. However, they serve as excellent specific characters.

Nymphs

It is not possible at the present time to more than mention the nymphs of this tribe. Since I have no life history material I have been able to recognize only those nymphs which belong with the gill-bearing species. Of course the form and location of the gills is characteristic. The shape of the head is distinctive also, being curiousy broadened laterally by very large maxillae. In the following specific descriptions two nymphs are described in detail.

Morphological Notes

This group, like *Pteronarcella*, is so little known as yet that it has not been studied from biological or morphological viewpoints. At the end of Hagen's description of *Megarcys* (*Dictyogenus*) *signata* he commented upon the fact that the species was of special interest, as an exception to the genus, since it was gill-bearing in the adult, that the hitherto-known species (all exotics) were without them. Among the following descriptions of additional North American species a number of other gill-bearing imagos will be found.

Judging alone from the appearance of the external genitalia of the males of this tribe one would not imagine that a close relationship existed between them. But dissections of the supra-anal plates show not only that the fundamental plan of all of them is identical, but also that it is similar to that of *Pteronarcella* and the *proteus* group of *Pteronarcys*. This tribe appears to have reached a higher degree of specialization in at least one respect, that is in the more complicated form of the outer portion of the free end of the supra-anal plate. In all of these (figs. 40, 45, 50) it is made up of three parts, which I am calling the median and lateral stylets. The paired ones are joined to the median one at the bases only, but they appear to have a secondary connection with the para-genital plates, being bound to them by bands of membranous tissue, so that all movements of the plates involve the stylets in a similar movement.

The variety of form in all the stylets is considerable and of such a character in some instances as to prevent certain conjectures of function. One can doubtless say with a good deal of surety, that whatever their use may be it is as some accessory copulatory organ. It does not seem improbable that the median

one may function as a probe for opening up the vagina of the female. Whether it be a probe or some other intromittent organ, there is present, presumably, a true penis, directly connected with the sperm ducts, for the transference of the spermatozoa.

Arcynopteryx vagans is, perhaps, most nearly related to the preceding genera. The inner end (fig. 50, I) is short and stout with its posterior dorsal aspect forked. It seems very probable that the bifid portion represents lateral braces (fig. 50, L. B.) in a more highly developed condition. The free end (fig. 50, F) is made up of the characteristic parts, a stout, chitinous, club-shaped, median stylet surrounded by a membranous sheath (fig. 50, M. S.) and on either side of it, a shorter bifid stylet. These lateral stylets (fig. 50, L. S.) are chitinous but much more delicate than the median one; the two tips are unlike in form, the inner one which is scarcely visible in a side view of the supra-anal plate, is somewhat thumb-shaped, and the outer, longer and more spine-like. Broad para-genital plates (fig. 50, P. G. P.) surround the free end posteriorly and laterally, these are articulated to the posterior margins of the lateral braces, and are joined to the inner end by bands of muscle (fig. 50, M).

In *Protarcys bradleyi* the inner part (fig. 40, I) is reduced to a mere stub, but the lateral braces (fig. 40, L. B.) are correspondingly larger. The median stylet (fig. 40, M. S.) is shorter than the laterals (fig. 40, L. S.); it is not unlike that of *Arcynopteryx vagans* in structure, being a chitinous rod surrounded by a fleshy covering, which is beset with innumerable tiny teeth directed ventrally; the paired stylets are slender tapering rods nearly reaching the dorsal margins of the para-genitals. These latter plates are large and rather triangular in form; they have the usual relations to the other parts already described under *Arcynopteryx vagans*.

The supra-anal plate of *Megarcys signata* has a very curious appearance. The inner end (fig. 45, I) is larger than in the preceding forms and the lateral braces (fig. 45, L. B.) are stout; the greater development of this region is necessitated, perhaps, by the extraordinary size of the rest of the apparatus. The median stylet (fig. 45, M. S.) is a large, flat, triangular, chitinous plate,

the posterior end of which is surrounded by a membranous covering studded laterally and ventrally with minute, triangular teeth; the lateral stylets (fig. 45, L. S.) are flat, elongate lobes with pointed tips. There is nothing unusual in the form of the paragenital plates (fig. 45, P. G. P.) or in the connections with the other parts. Although the form of the median stylet is very different from those just described, it probably functions in the same way. In copulation, if the end of the abdomen were arched dorsalward sufficiently, it would bring the pointed posterior end, anterior in position and it would be introduced into the vagina first. The rough membranous sheath, covering this portion of the stylet, is a further indication that it is the probe end. It is possible that the entire stylet is extended into the vagina; its triangular shape would make it an excellent wedge for prying open the passage.

Key to Genera of Perlodini

Adults

a. In the fore-wing an apical network of cross-veins extending from costa to cubitus$_1$ ..... **Protarcys**

aa. In the fore-wing an apical network of cross-veins of lesser extent.

b. Costal margin of the wing showing a slight concavity at the humeral cross-vein; the length of the inner inter-radial cell at least twice as great as its base (p. 475); the network of cross-veins restricted to the anterior part of the wing, chiefly between radius and the branches of the sector. **Arcynopteryx**

bb. Costal margin of the wing not showing a slight concavity at the humeral cross-vein; the length of the inner inter-radial cell only a little greater than its base.

c. A rich network of cross-veins extending from costa to media$_1$. **Megarcys signata**

cc. A scanty network of cross-veins restricted to the region between radius$_2$ and media$_1$ ..... **Dictyogenus? phaleratus**

PERLODES Banks

1903. *Perlodes* Banks, Ent. News, XIV, p. 241.
1912. *Perlodes* Klapálek, Coll. Selys, 4:31.

In giving the distribution of the genus *Perlodes*, Klapálek says that it is spread over Europe and is represented in America by a single species. Among his specific descriptions we find on page 40 a sketch bearing the legend "*Perlodes transversa* Klp. (Nord Amerika)," but he gives as the basis for the description one

female specimen with the label "Rheinwald" (W. Bennett collector). On account of this apparent discrepancy in locality I am neither accepting *Perlodes transversa* as an American species, nor including *Perlodes* in this tribe, since I have not found any representatives of it among our material.

PROTARCYS Klapálek

1912. *Protarcys* Klapálek, Coll. Selys, 4: 8.

"Wings surprisingly short and broad, especially the hind ones. Cross-veins numerous, only lacking in field M_1"—translation from Klapálek's description of the genus. The lack of cross-veins in field M_1 is not constant in this genus. Klapálek mentions their presence in one of his specific descriptions, *Protarcys caudata* Klp., p. 9. I am, therefore, placing here two American species which have a rich network of cross-veins extending from costa to the second branch of cubitus including field M_1. The wings are not surprisingly short and broad, but the similarity between the genitalia of the male which Klapálek describes and figures, and that of the male I am placing here is so striking that it seems to indicate close kinship.

The American species have additional venational characters; the costal margin does not show a slight concavity at the humeral cross-vein, practically the entire costal area beyond the humeral cross-vein is occupied by numerous cross-veins, subcosta runs into radius beyond the level of the cord, the length of the inner inter-radial cell is about a fourth greater than its base, the cord[5] ("anastomosis" of Banks and Klapálek) is well developed. The ninth sternite forms a short, subgenital plate; the tenth tergite is cleft, each lobe being produced into a short, stout projection directed inward and upward; in the species which we have the para-genital plates are the only parts of the supra-anal plate which are visible without dissecting. Both of the American species bear gills.

[5] The fullest discussion of this feature of insect venation is to be found on page 223 of Prof. J. G. Needham's "Report of the Entomological Field Station conducted at Old Forge, N. Y. in the Summer of 1905"—New York State Museum Bulletin 124.

Key to Species of Protarcys

Adults

a. With one pair of tracheal gills; the apical network of cross-veins rich and regular (fig. 59) ..... **dolobrata**

aa. With three pairs of tracheal gills, the apical network of cross-veins fairly rich and irregular (fig. 60) ..... **bradleyi**

Protarcys dolobrata new species

Adult

♀.—Length to tip of wings, 25 mm.; expanse of wings, 44 mm.

Color, dull, dark brown. Head large, with three small ocelli arranged in an isosceles triangle, the distance between the posterior ocelli half again as great as that between them and the anterior ocellus, and about equal to the distance from them to the inner margin of the eye. Small, round, glossy tubercles much closer to the paired ocelli than to the inner margin of the eyes. M-shaped mark fairly distinct, brownish yellow. Crown-spot and region around the tubercles brownish yellow; median occipital border with a pale yellow triangular spot, lateral occipital areas dull brown with coarse embossings. Under side of head brownish-yellow, palpi of the same color, antennae broken off, except for basal segments which are brown.

Prothorax, trapezoidal, slightly broader than the occiput, considerably narrowed posteriorly, sides straight, front margin a trifle arcuated, posterior border more noticeably convex, angles blunt. A small, pale yellow, median spot on the anterior and posterior margins, a deep median furrow, lateral fields embossed, especially on the inner halves. Venter of thorax pale yellow with a dark brown, median, shield-shaped spot on each of the three segments. Legs dark brown with middle regions of femora and tibiae paler. Wings long and slender, with yellowish-brown venation; costa paler, veins smoky, a rather conspicuous brown spot on the radial cross-vein; apical half of the wings with a rich network of cross-veins extending from costa through cubitus$_2$, cells fairly regular (fig. 59). On a line with the base of the legs on the anterior post-marginal area of the mesothorax a pair of rather short, fleshy gills. The same area on the metathorax is so badly mutilated that it is impossible to determine whether a pair of gills was ever present or not. The part of the body anterior to the mesothorax is perfect and there is no trace of gills there.

Female. Abdomen dull brown above and below with the exception of yellowish-brown median areas on the first seven sternites; sub-anal plates and first few basal segments of the setae pale yellow, the following segments pale yellow with narrow apical bands of brown. The vulvar lamina rather long and narrow reaching across segment nine and the basal part of segment ten; semi-elliptical in form, apex truncate (fig. 39).

Type specimen, a single female without a locality label, in the collection of the Academy of Natural Sciences of Philadelphia.

Male unknown.

Nymph unknown.

Protarcys bradleyi new species

Adult

Distribution.—Canadian Rocky Mountains.

♂.—Length to tip of wings, 20 mm.; length of antennae, 12 mm.; expanse of wings, 32 mm.

♀.—Length to tip of wings, 23 mm.; length of antennae, 12 mm.; length of setae, 7 mm.; expanse of wings, 37 mm.

Dark brown varied with golden brown and yellow. Head triangular, three moderately large ocelli arranged in an isosceles triangle, the distance between the lateral ocelli one-third greater than the distance from them to the median ocellus and very nearly as great as the distance from them to the inner margin of the eye. The M-shaped mark yellow-brown, glossy, conspicuous; tubercles shiny reddish-brown, in the form of crescents, the distance from them to the posterior ocelli half as great as the distance from them to the inner margin of the eyes. Labrum whitish; clypeus with a yellowish brown, median area and a pale yellow spot toward either anterior corner; a yellow-brown, inverted V-shaped mark passing from the median ocellus backward to the posterior ones; crown suture deep, pale yellow; a large, median, pale yellow, occipital spot which extends laterally in a narrow band along the entire occipital border; the lateral areas of the occiput with rather fine, dark brown sculpturings. Antennae, long, slender, over half the length of the body, the basal segment dark brown, in the male the second and third segments pale and the remainder dark brown, in the female the entire antenna pale brown with the exception of the dark basal segment. Under side of head pale yellow; palpi, white.

Pronotum trapezoidal, anterior border wider than posterior but narrower than the occiput; sides and hind margin straight, front margin a little arcuated, corners squarish; a very dark brown band along the anterior border interrupted in the middle by a median yellow band, moderately broad and dilated posteriorly; the lateral areas darkest in the outer half, coarse, yellowish brown sculpturings in the inner part. Meso- and metanotum dark brown with pale median bands. The entire venter of the thorax yellowish white, with a more or less rectangular dark brown spot toward the middle of each of the three segments. Legs yellowish brown, the distal half of the femora, a band below the knees, the tip of tibiae and the tarsi, darker. Wings yellowish brown, venation rather dark, veins somewhat clouded; an irregular network of cross-veins in the tip of the wing, extending from costa through cubitus, the cross-veins fewer in the median and cubital fields, but not entirely lacking (fig. 60). Three pairs of white, fleshy, tracheal gills in the form of short, slender blind sacs situated as follows: one pair (small and inconspicuous) far apart on the lateral margin of the submentum, and a pair each on the anterior post-marginal border of the meso- and metasternum on a line with the lateral posterior border of the base of the legs.

Abdomen dark brown above with a median pair of narrow paler stripes, conspicuous on the basal segments but gradually becoming fainter toward the tip and disappearing in the male on the fifth segment and in the female on the

eighth. Abdomen pale on the venter in the female, dark in the male. Setae slender, pale brown in the male, yellowish in the female; the distal segments narrowly banded with darker toward the tips.

Male. Ninth segment entire above, slightly produced below to form a narrow subgenital plate which extends to the posterior border of the tenth segment. The tenth tergite with a broad median cleft, the opposed edges of the lobes emarginate with a broad, yellow, triangular hollowed spot extending lateralward from the margin and a short, spine-like projection directed obliquely inward and upward on the inner posterior edge of the lobe. Supra-anal plate entirely concealed except for the tips of the lateral braces, which show at the apical border of the ninth tergite, projecting from the inner anterior borders of the cleft of the tenth tergite, as a pair of short, dark brown, triangular processes pointing obliquely upward and outward. Sub-anal plates, flat, triangular, pressed against and meeting at right angles, the para-genitals which appear between the lobes of the cleft and the tenth tergite as a pair of yellowish brown, horizontal, triangular lobes (fig. 41).

Female. The posterior border of the eighth ventral segment prolonged about three-quarters of the distance across segment nine, in an evenly rounded subgenital plate (fig. 42). The tenth tergite scarcely elongated; the tips of the sub-anal plates touching its ventral surface and concealing the supra-anal plate, if it is present

We have three specimens collected by J. C. Bradley; one male (alcoholic) from Lake Louise, Canadian Rockies, VI, 25, 1908; and two females, one (alcoholic) from Rogers Pass, (altitude 4500 to 5000 feet) British Columbia, VIII, 7, 1908; and one from Ground Hog Basin (altitude over 6000 feet), Selkirk Mountains, British Columbia, VII, 22 to VIII, 7, 1905. The male is the type specimen and the female from Rogers Pass, the allotype. These are at Cornell University in the entomological collection.

Nymph unknown.

MEGARCYS Klapálek

1912. *Megarcys* Klapálek, Coll. Selys, 4: 10.

In characterizing this genus Klapálek says it is quite close to *Arcynopteryx* in the structure of the genital appendages, but it is sufficiently distinct from it in having a much richer network of cross-veins. To enlarge upon Klapálek's statement, in the male the ninth sternite is produced to form a subgenital plate, the tenth tergite is bifid, the inner posterior margin of either lobe is prolonged into an appendage-like process directed upward; the sub-anal plates are flat, and triangular; the supra-anal plate consists of a pair of para-genitals, a median and two lateral

stylets. In *Megarcys signata* only the tips of the lateral stylets are visible, they are so closely applied to the median one that they are very inconspicuous. In this same species the apical network of cross-veins is rather irregular, it extends from costa to media$_1$, the costal border does not show a slight concavity at the humeral cross-vein, the first third or fourth of the costal area beyond the humeral cross-vein is free from cross-veins, the remainder of that area is more or less closely traversed with cross-veins; subcosta runs into radius beyond the level of the cord; the length of the inner inter-radial cell is a fourth greater than its base in females and long winged males, and about equal to its base in short winged males; cord well developed. *Megarcys signata* bears gills.

Megarcys signata Hagen

1873. *Dictyopteryx signata* Hagen, Bull. Geol. Surv. Terr., p. 575.
1907. *Perlodes signata* Banks, Cat. Neur. Ins., p. 10.
1907. *Perlodes signata* Banks, Can. Ent., 39: 327.
1912. *Megarcys signata* Klapálek, Coll. Selys, 4: 12.
1900. *Dictyopteryx irregularis* Banks, Trans. Ann. Ent. Soc., 26: 243.
1907. *Perlodes irregularis* Banks, Cat. Neur. Ins., p. 10.
1907. *Perlodes irregularis* Banks, Can. Ent., 39: 327.
1912. *Megarcys irregularis* Klapálek, Coll. Selys, 4: 12.

Distribution.—Colorado; Mountains of Pacific Coast; Ashford, Washington; British Columbia; Wyoming.

♂.—Long winged, length to tip of wings, 20 mm.; expanse of wings, 30 mm.

♂.—Short winged, length to tip of abdomen, 16 mm.; expanse of wings, 18 mm.

♂.—Length of antennae, 12 mm.; length of setae, 9 mm.

♀.—Length to tip of wings, 25 mm.; length of antennae, 12 mm.; length of setae, 11 mm.; expanse of wings, 42 mm.

Yellowish-brown varied with yellow, paler beneath. Head flat, triangular. Three small ocelli forming an isosceles triangle, the base of the triangle greater than the sides, in the male the distance from the inner margin of the eye to the posterior ocellus less than the distance between the anterior and posterior ocelli; in the female the distances about equal. On either side outside the ocellar triangle is a small rather inconspicuous tubercle. Color pattern of the head more or less variable; labrum pale yellow, entire clypeus pale, or frequently only the middle portion pale with the sides brown, the M-shaped mark varying from pale yellow to brown; a pale spot between the ocelli, and three on the occipital margin, in some specimens the middle one small and triangular, narrowly connected with the crown spot, in other specimens the middle spot broadly confluent with the crown spot; the lateral occipital spots more or less

conspicuously corrugated with brown. Antennae pale brown, first segment with a tendency toward darker coloration above. Under side of head pale; palpi pale to brownish.

Pronotum yellowish-brown, about as broad as the head, nearly square, in one male specimen slightly wider posteriorly; occasionally anterior and posterior margins a trifle arcuated; a broad, median, yellow band dilated at either end, the posterior dilation greater than the anterior, in some specimens a fine, brown stripe running through the center of the yellow band, the lateral areas conspicuously marked with shiny, brown embossings. Above, the meso- and metathorax glossy dark brown with a pale, median, narrow, triangular spot on the anterior border. The entire thorax whitish beneath, with darker markings on the middle areas. Legs yellowish-brown, femora with stripes of brown along the outer aspect, broadening into a ring above the knees, base of tibiae and tip of tarsi dark brown. Wings brownish-yellow, darker on the costal margin, a rich network of cross-veins in the apical part of the wing in the region anterior to media (fig. 61). Males both long and short winged. Four pairs of tracheal gills (not five as stated by Hagen p. 576) in the form of small, white, fleshy, blind sacs, situated as follows; one pair placed far apart on the basal portion of the submentum and pointing outward, a pair on the prothorax a little lateral and anterior to the base of the fore legs, and a pair on the anterior post-marginal area of each of the last two thoracic segments on a line with the base of the legs, these point obliquely inward and downward.

Abdomen dark brown above, pale at the tip and beneath, setae about two-thirds as long as the body, brownish, darkest at the tips of the segments.

Male. The apical half of the ninth segment, yellow; on the dorsum its posterior border recurvate, transversely cariniform, thickened, slightly emarginate in the middle region, villous; on the venter the ninth segment considerably produced with an elliptical margin. The tenth segment concealed by the ninth below, cleft above with yellow, appendage-like, spinous, processes directed upward, on the inner posterior margin of either lobe. In one specimen a brown band across the process, just before the tip. Between the posterior border of the tenth dorsal segment and the sub-anal plates the para-genitals show on either side of the stylets. The median stylet rises above the para-genitals as a thin, rod-like appendage directed obliquely backward, the anterior portion is brown, while the posterior part appears white, being ensheathed with a membranous covering, on either side of the anterior portion of the central portion of the stylet, and closely opposed to it, the laterals show as small triangular plates (fig. 43).

Female. Subgenital plate large, reaching about two-thirds across segment nine, and nearly three-quarters as wide as the segment, with a deep, narrow median cleft forming two circular lobes very close together. The tenth tergite triangularly produced with a slight, median longitudinal depression (fig. 44).

We have four males (three alcoholic); one (long-winged) from Howser, Selkirk Mountains, British Columbia, VI, 22, 1905 (Bradley); one (short-winged) from Emerald Lake, Canadian

Rockies, VII, 4, 1908 (Bradley), and two, one (long-winged) and one (short-winged), from Wyoming; also five females (all alcoholic), four from Rogers Pass, Selkirk Mountains, British Columbia, VIII, 1908 (Bradley), and one from Wyoming. Hagen gives September as the date of occurrence for the foothills of Colorado, and August 16 to September 6 for the mountains of the Pacific Slope.

Type specimen of species in the Museum of Comparative Zoology, Cambridge, Mass.

Nymph

Immature nymphs. Length to tip of abdomen, 18 mm.

Color, pale yellow-brown varied with yellowish markings. Head squarish, considerably broadened on the sides by enormous maxillae. Three small ocelli arranged in an isosceles triangle, the side of which is less than the base but equal to the distance from the inner margin of the eyes to the posterior ocelli. On either side of the ocellar triangle a pale yellow tubercle, a prominent M-shaped mark of the same color, the region anterior to the middle part of the M also pale, labrum and lateral portions of clypeus brown; lateral occipital areas with rather large, oval spots, in some specimens also a small, triangular median occipital spot and an indistinct one between the ocelli. Under side of head, palpi and antennae pale.

Pronotum much narrower than the head, broader than long, anterior border straight; sides and posterior margin convex; front angles blunt, hind ones considerably rounded off; a narrow, pale yellow median line, inner halves of the lateral fields with pale sculpturings, meso- and metanotum similarly marked. The entire venter of the thorax pale yellow. Legs pale yellow, except for the dorsal aspects of the trochanters, coxae and femora which are brown; thick fringes of long, fine hair along the outer edges of the femora and tibiae. Four pairs of tracheal gills in the form of slender, finger-like, blind sacs situated as follows; one small pair far apart on the base of the submentum, the second pair, which is also small, on the latero-anterior border of the base of the front legs, the third and fourth pairs on the latero-anterior sub-marginal areas of the meso- and metasternum on a line with the inner borders of the base of the middle and hind legs (fig. 46).

Abdomen brown above, yellow below. Setae pale yellow, each articulation surrounded by a whorl of short, stout, brown hairs, a thick fringe of long, fine hairs along the mid-dorsal line of each seta. The posterior border of the tenth tergite slightly produced; the supra-anal plate, a fleshy lobe attached to the ventral side of the posterior border of the last tergite (fig. 47, Sup. A. P.); sub-anal plates, triangular (fig. 47, Sub. A. P.).

The general form and coloration of these nymphs indicates that they belong in this tribe, and since they agree with the adult *Megarcys signata* in size, number, and location of the gills, I am placing them in that species tentatively.

Six immature specimens from Goat Creek, Ashford, Washington, (Miss Hortense Butler), XI, 12, 1905, in the entomological collection at Cornell University, Ithaca, New York.

ARCYNOPTERYX Klapálek

1904. *Arcynopteryx* Klapálek, Bull. Intern. Acad. Scien. Bohême, no. 17: 7.
1912. *Arcynopteryx* Klapálek, Coll. Selys, 4: 13.

In making a general statement concerning this genus, Klapálek says that it is closely related in the character of the venation to *Perlodes* Banks, but is totally different from it in the structure of the genitalia. In the American species the apical network of cross-veins is irregular and restricted to the anterior part of the wing, it extends chiefly between costa and the branches of the radial sector; the costal margin shows a slight concavity at the humeral cross-vein; with the exception of *Arcynopteryx aurea*, at least the first third (often considerably more) of the area beyond the humeral cross-vein free from cross-veins; except in *Arcynopteryx vagans* and *aurea* subcosta passes into radius before the level of the cord; the length of the inner, inter-radial cell at least twice as great as its base.

In the male the ninth sternite forms a subgenital plate; the tenth tergite is bifid, the posterior inner margin of each lobe is prolonged into an appendage-like process which is directed dorsalward; the supra-anal plate consists of a pair of para-genital plates, and median and lateral stylets. In *Arcynopteryx vagans*, the only species of which we have a male, the para-genital plates are the only parts that are visible without dissection.

Adults of some species of this genus are gill-bearing.

With one exception, the new species which I am including in this genus are based on venational characters and are represented only by females.

Key to Species of Arcynopteryx[6]

Adults

a. Without tracheal gills.
  b. An apical network of cross-veins in the area between costa and the branches of the radial sector . . . . . **inornata**
  bb. An apical network of cross-veins in the area between costa and media. **ignota**

[6] *Arcynopteryx minor* Klapálek, from Arctic America, is omitted in this key, since it is unknown to me and since Klapálek does not figure it.

aa. With tracheal gills.

b. With five pairs of gills.

c. A little less than the first half of the costal area beyond the humeral cross-vein free from cross-veins; the upper branches of the radial sector forked ..... **vagans**

cc. Only a small costal area beyond the humeral cross-vein free from cross-veins; the upper branches of the radial sector not distinctly forked, but merged with the network of cross-veins ..... **aurea**

bb. With two pairs of gills.

c. Female vulvar lamina trapezoidal, with a shallow, U-shaped, apical notch ..... ♀ **lineata**

cc. Female vulvar lamina truncate, scarcely produced beyond the border of the eighth segment but cut off from it by oblique corners. ♀ **americana**

Arcynopteryx lineata new species

Adult

Distribution.—Old Forge, New York.

♀.—Length to tip of wings, 22 mm.; expanse of wings, 34 mm.; length of antennae, 9 mm.; length of setae, 11 mm.

Color dark brown varied with yellow, pubescent. Head with three small ocelli arranged in an isosceles triangle, the lateral ocelli equidistant from each other and the inner margin of the eyes, the distance between them a third greater than the side of the triangle. On either side of the ocellar triangle, a little closer to the lateral ocellus than to the inner margin of the eyes, is a rather flat, elliptical tubercle. M-shaped mark fairly prominent. Head, yellowish-brown, a blackish-brown, rectangular, frontal spot with short horns extending posteriorly to the paired ocelli; entire occipital border yellow with a broad, median, triangular extension passing forward with its apex in the apex of the ocellar triangle; anterior to the yellow border, a dark brown coarsely sculptured oval area on the lateral occipital regions. Under side of head yellowish, palpi and antennae brown.

Prothorax quadrangular, wider than the occiput, breadth almost twice as great as the width, front and hind margins a little convex, sides straight, angles rounded; a broad, median, yellow stripe, inner lateral fields with glossy corrugations. Meso- and metanotum dark brown. Venter of thorax pale with a large, brown, median, shield-shaped spot on each of the three segments, on the anterior border of the last two segments, transverse bands running out from the median spots. Legs dark brown with femora and upper part of tibiae a little paler in coloration. Wings with yellow-brown venation, an irregular network of cross-veins between costa and the branches of the radial sector; nearly the first half of the costal area beyond the humeral cross-vein free from cross-veins; the length of the inner inter-radial cell three times as great as its base. A single pair of small, white, fleshy, finger-like gills on the lateral margins of the submentum.

Female. Abdomen uniformly dark brown; basal segments of the setae brown, the following ones alternately ringed with white and brown, each segment being marked with a narrow, basal, ring of white followed by first a narrow brown, then a narrow white band and finally a broad, brown, terminal ring. Vulvar lamina trapezoidal with a broad, shallow, V-shaped, apical notch (fig. 48).

One female specimen from Old Forge, New York, VIII, 16, 1905, (J. G. Needham), in the collection at Cornell University, Ithaca, N. Y., is the type of this species.

Male unknown.

Nymph unknown.

Arcynopteryx aurea new species

Adult

Distribution.—California.

♀.—Length to tip of wings, 21 mm.; expanse of wings, 32 mm.

This species is apparently rather closely related to *Arcynopteryx vagans*. It is yellowish-brown with yellow markings. Head triangular, three small ocelli arranged in an isosceles triangle the base of which is greater than the sides, the distance from the inner margin of the eyes to the posterior ocelli less than the distance between the posterior ocelli, but greater than that from them to the anterior ocellus. Outside the ocellar triangle, conspicuous, dark brown tubercles situated a little nearer the paired ocelli than the inner margin of the eyes. M-shaped mark prominent. The anterior region of the head uniform yellowish brown, the occiput with three pale yellow spots, a small median triangular one with larger oval ones on either side. Under side of head, pale, palpi brown.

Pronotum quadrangular, wider than the occiput and a little wider than long, only slightly narrowed posteriorly, sides straight, anterior border markedly convex, posterior one a trifle arcuated, anterior angles rather sharp, posterior ones rounded; a broad median yellow stripe, lateral fields embossed. A similar, broad median stripe on the mesonotum, and a small median marginal spot on the anterior border of the metanotum. Venter of thorax pale with a median shield-shaped darker marking on each of the three segments, from these dark median spots on the last two segments, transverse extensions run out laterally just anterior to the base of the legs. Legs yellowish-brown, bases and tips of femora and tibiae, and tarsi, dark brown. Tips of wings broadly rounded, venation pale brown; a rich irregular network of cross-veins between costa and the anterior branches of the sector, in the fore-wing there is not a long costal area beyond the humeral cross-vein that is free from cross-veins, subcosta passes into radius slightly beyond the level of the cord, the length of the inner inter-radial cell twice as great as its base, first anal vein forked (fig. 64). Five pairs of long, white, slender, fleshy, finger-like tracheal gills arranged as in *Arcynopteryx vagans*, one pair widely separated on the base of the submentum, a second pair on a line with the first in the articulation between head and thorax,

the third pair, a little lateral and anterior to the base of the fore legs, the fourth and fifth pairs in the same relative position on the meso- and metathorax.

Female. Abdomen brown above and below; vulvar lamina paler, large and shining, produced nearly across segment nine; the posterior border in the form of a W with rounded angles (fig. 49).

Described from a single type specimen from California. This is in the entomological collection at Cornell University, Ithaca, New York.

Male unknown.

Nymph unknown.

Arcynopteryx vagans new species

Adult

Distribution.—Nevada County and San Diego, California.

♂.—Long-winged. Length to tip of wings, 16 mm.; expanse of wings, 26 mm.

♂.—Short-winged. Length to tip of wings, 14 mm.; expanse of wings, 21 mm.

♂.—Length of antennae, 16 mm.; length of setae, 11 mm.

Yellowish-brown varied with yellow markings on the head and thorax, and paler beneath. Head triangularly produced; three small ocelli placed in an isosceles triangle, its base greater than the sides, the distance from the inner margin of the eye to the posterior ocellus greater than the side of the triangle but not as great as the base. On either side of the ocellar triangle, a glossy, dark brown, oval tubercle, somewhat nearer the posterior ocellus than the inner margin of the eye. M-shaped mark conspicuous. Labrum whitish. From the tubercle a broad, dark fuscous area extending laterally to the eye and encircling its inner margin with a narrow band which spreads out posteriorly, covering the entire occipital region behind the eye, anteriorly the band broadens and runs along the lateral border of the frons and clypeus. In one specimen at the level of the anterior ocellus, a transverse bar connecting the dark areas of either side, in the same specimen, from the tubercle a posterior extension, running slightly diagonally inward to the occipital margin. Three pale yellow, coarsely corrugated spots on the posterior border of the occiput, a small median triangular one with its apex directed forward, and on either side close to the dark fuscous areas behind the eyes, a large oval spot. Antennae brown, stout, as long as the body; palpi brown; under side of head, pale.

Pronotum trapezoidal, anterior border wider than the posterior and wider than the occiput, sides and posterior margin straight, anterior margin convex, front angles rather sharp, hind angles rounded off; a broad, median, yellow stripe, conspicuous, glossy brown, embossed markings on the lateral fields. Meso- and metanotum dark brown with the median yellow band of the pronotum continued upon them. The entire venter of the prothorax pale with darker markings. Legs yellowish-brown; bases and tips of femora and tibiae,

and tip of tarsi, ringed with dark brown. Wings with fine yellowish-brown venation, an irregular network of cross-veins occupying the tip of the wing in the region between radius and the anterior branches of the sector; a little less than the first half of the costal area beyond the humeral cross-vein free from cross-veins; subcosta runs into radius beyond the level of the cord; the length of the inner inter-radial cell twice as great as its base (fig. 63).

Both long and short winged males, in the latter the wings are not greatly shortened, they extend to the tip of the abdomen. Five pairs of long, white, slender, fleshy, finger-like, tracheal gills arranged as follows; one pair widely separated on the base of the submentum, a second pair on a line with the first in the articulation between head and thorax, the third pair a little lateral and anterior to the base of the fore legs, the fourth pair on the anterior border of the mesothorax on a line with the base of the legs, and the last pair in the same relative position on the metathorax.

Male. Abdomen dark brown above and on the sides, pale on the venter. Setae about three-fourths the length of the body; pale brown, conspicuously ringed with darker and provided with whorls of fine bristle-like hairs toward the tip of the segments. The seventh dorsal segment triangularly produced over the eighth, and ending in a strong, upright median fork; the eighth segment, normal; the ninth entire, narrow above, elongated below into a conspicuous subgenital plate marked with fine transverse striae, a median villous area set off from the lateral parts by prominent carinae. The tenth segment concealed by the ninth on the venter; widely cleft above, each lobe with an erect appendage-like process on the inner posterior margin; sub-anal plates boat-shaped, flaring; stylets entirely concealed by the para-genitals which appear between the posterior border of the tenth tergite and the sub-anals, as a pair of lateral chitinous sheaths with a white, membranous median portion (fig. 51).

In the entomological collection at Cornell University there are three male specimens, two (alcoholic) from San Diego, California, IV, 23, 1879, and one from Nevada County, California (C. V. Riley collector). One of the specimens from San Diego is the type of this species.

Female unknown.

Nymph unknown.

Arcynopteryx ignota new species

Adult

♀.—Length to tip of wings, 17 mm.; expanse of wings, 29 mm.; length of setae, over 11 mm. (those on the specimen measure 11 mm. but they are broken).

Dark brown, with a few paler markings. Head triangularly produced; three moderately large ocelli arranged in an isosceles triangle, the base of which is greater than the sides, but less than the distance from the posterior ocelli to the inner margin of the eyes; the M-shaped mark present but not prominent,

small, round, inconspicuous tubercles situated nearer the posterior ocelli than the inner margin of the eyes. The lateral borders of the clypeus pale yellow; a dark fuscous crown spot in the form of a letter X with its center in the median ocellus, the anterior part outlining the middle region of the M and the posterior part extending back to the lateral ocelli; a median, deep yellow, occipital spot reaching forward between the ocelli; dark brown, coarsely sculptured, oval-shaped spots on the lateral occipital areas. Antennae brown, the basal segment the darkest; under side of head pale, palpi dark brown.

Pronotum rectangular, not as broad as the head; sides straight, front and hind margins convex, angles blunt; a yellow median band, broader behind; the inner regions of the lateral fields with embossed markings. Meso- and metanotum and the entire venter of the thorax, with the exception of narrow areas surrounding the bases of the legs which are paler, dark brown. Legs brown except a pale band before the knees and pale tibiae. Wings with yellow-brown venation, except basal portions of costa and sub-costa in fore-wing and all bases in hind wing which are yellow; an irregular network of cross-veins extending from costa through the anterior branches of the sector, the network richest between $radius_1$ and $radius_2$, over the first half of the costal area beyond the humeral cross-vein free from cross-veins; the length of the inner inter-radial cell twice as great as its base. Without gills.

Female. Abdomen uniformly dark brown, setae long and slender; alternately ringed with dark brown and white, except for the first few basal segments, which have but a single ring of dark and light, each segment is marked with a white basal band followed first by a narrow brown, then a narrow white ring, and finally a broad brown one. The eighth ventral segment produced somewhat triangularly with a rectangular notch in the tip. Sub-anal plates, large, triangular (fig. 52).

Described from a single specimen, the type, without locality label, in the collection of the Academy of Natural Sciences of Philadelphia.

Male unknown.

Nymph unknown.

Arcynopteryx inornata new species

Adult

♀.—Length to tip of wings, 17 mm.; expanse of wings, 30 mm.

Of an almost uniform dark brown coloration. Head rather triangular, so perfectly concolorous that the M-shaped mark, ocelli and tubercles are scarcely visible; palpi and under side of head also dark brown; basal segment of antennae dark brown, succeeding segments slightly paler.

Pronotum trapezoidal, a little broader posteriorly, and the anterior border a trifle wider than the occiput, sides straight, front and hind margins slightly arcuated, angles squarish; a broad, median, yellow band, lateral fields with a few coarse embossings. Meso- and metanotum, dark brown, also the entire venter of the thorax, except for small, pale areas around the bases of the legs. Legs yellowish brown.

Wings with fine yellow-brown venation, an irregular, scanty network in the tip between costa and the anterior branches of the radial sector; at least the first half of the costal area beyond the humeral cross-vein free from cross-veins; in the fore wing the length of the inner inter-radial cell twice as great as its base and cross-veins between media and cubitus$_1$, and cubitus$_1$ and cubitus$_2$, few (fig. 62). Without gills.

Female. Abdomen dark brown above and below. Setae long, slender; the first few segments yellowish, the rest, ringed with darker toward the tips. The vulvar lamina large, reaching nearly to the posterior border of the ninth segment, it is in the form of a wide truncate triangle with a broad, shallow, rounded notch in the tip (fig. 53).

Type specimen, of unknown locality, in the collection of Academy of Natural Sciences of Philadelphia.

Male unknown.

Nymph unknown.

Arcynopteryx americana Klapálek

1912. *Arcynopteryx americana* Klapálek, Coll. Selys, 4: 21.

Adult

Distribution.—Colorado (Klapálek), Wyoming.

♂.—Length of body, 13 mm. (Klapálek).

♀.—Length to tip of wings, 22 mm.; expanse of wings, 34 to 36 mm.; length of antennae, 12 mm.; length of setae, 11 mm.

The following description of the coloration of the male is translated from Klapálek:

"In the male the entire occiput is ochre-yellow and this color extends in a narrow band along the inner margin of the eyes and joins in the middle the spot between the ocelli; the frons, with the exception of ochre-yellow tubercles and small yellow spots outside the posterior ocelli, is dark brown almost to the M line which is also ochre-yellow, then it passes again anteriorly into the dark anterior border of the clypeus. The under side of head is ochre-yellow. The middle field of the pronotum bright ochre-yellow, the sides brown, somewhat brighter toward the inside and darker outside. Meso- and metanotum shining dark brown, the middle parts of the praescutum and scutellum ochre-yellow; on either side a lighter band extending from the praescutum to the base of the wings. Abdomen brown on the dorsum, the entire venter reddish yellow-brown. Antennae brown, paler on the under side, but the first segment dark brown; palpi brown, legs yellow-brown, the outer aspect of the femora with a dark line along the edge, tibiae beyond the knees, and the feet, brown. Setae yellow-brown, indistinctly ringed with darker and sparsely beset with whorls of strong, bristle-like hairs."

The female is chestnut brown with yellow markings, paler beneath. Head dark brown, tubercles and M-line yellow; labrum and anterior corners of clypeus, whitish; posterior border of occiput broadly banded with yellow with a median extension running forward into the posterior half of the ocellar triangle; lateral occipital regions with a coarsely corrugated, oval-shaped spot just anterior to the yellow border. Antennae chestnut brown, a little over half the

length of the body. Palpi pale brown; under side of head whitish except lateral borders of mentum which are brown. Meso- and metanotum dark brown with a narrow, yellow median line on the anterior border; the entire thorax pale beneath with a median, dark brown, shield-shaped spot between the base of the legs, on each side of the three segments, and just anterior to the median spots a dark brown, transverse band on meso- and metathorax. Legs yellow brown, femora rather dark, knees pale, darker bands at base and tip of tibiae, and tip of tarsi.

Ocelli small, arranged in an isosceles triangle, the base of which is almost half again as great as the sides, the distance from the inner margin of the eye to the posterior ocelli less than the distance between the anterior and posterior ocelli. On either side of the ocellar triangle a glossy, kidney-shaped tubercle, placed a little nearer the posterior ocelli than the inner margin of the eyes.

Pronotum broader than long, about as wide as the occiput, sides straight, anterior and posterior borders slightly convex, corners blunt; a broad, median yellow band somewhat widened anteriorly and posteriorly, the lateral fields dark with indistinct sculpturings on the inner half. Wings rather short, in the male "the anterior ones reach the posterior border of the seventh segment and the posterior ones, the posterior border of the eighth segment" (Klapálek); in the female they just reach the tip of the abdomen; their color, brown; venation brown, except costa and base of subcosta which are yellowish; a scanty network of cross-veins in the apical part of the wing in the region before media; a little less than the first half of the costal area beyond the humeral cross-vein, free from cross-veins; the length of the inner inter-radial cell three times as great as its base. A single pair of slender, white, finger-like, tracheal gills widely separated on the base of the submentum.

Male. Klapálek says that *Arcynopteryx americana* is normally developed and that there is no departure from the generic type (fig. 54).

Female. Abdomen dark brown above and on the sides, pale on the venter. Setae slender, tapering, about half as long as the body; alternately yellow and dark brown, the apical half of the segment being the darker. The subgenital plate, truncate, about three-quarters as wide as the segment, scarcely produced beyond the margin of the segment but distinctly marked off from it by dark brown, oblique corners, or, in one specimen, slightly rounded corners. The tenth tergite triangularly produced; the supra-anal plate a fleshy rounded lobe attached to the ventral surface of the tenth tergite; the sub-anal plates triangular, broadly divergent (fig. 55).

We have two female specimens, one bearing simply the label, Wyoming, and the other (which has a more nearly dark brown general coloration than chestnut brown) from Little Laramie River, Hatton, Wyoming, V, 25, 1912.

Nymph unknown.

Arcynopteryx minor Klapálek

1912. *Arcynopteryx minor* Klapálek, Coll. Selys, 4: 22.

Distribution.—Arctic America.

♂.—Length of body, 11 mm.; ♀, 13 mm.; length of anterior wing of ♀ 14 mm.

"Anterior part of the body almost black, abdomen blackish brown, in the female yellowish spots on the venter. In the male the small crown-spot of the head joins the occipital bands and widens laterally along the crown suture; the sides of the clypeus are yellow-brown. In the female the occipital bands are indistinct, the crown-spot greatly reduced, but the sides of the clypeus are prominently bordered with yellow-brown. In the male the middle band of the pronotum occupies the entire middle field; in the female it is less conspicuous, but the lateral portions show light areas. The under side of the head is yellow-brown with a black-brown throat; otherwise the under side is black-brown, the venter of the female is lighter. Antennae black-brown, palpi dark brown. Legs dark brown, femora narrowly bordered with yellow-brown on the ventral edge, and broadly on the dorsal; tibiae yellow-brown for the most part. Setae shining bright brown.

"Head not as long as usual in the species of this genus and a little narrowed anteriorly. Eyes moderately large and spherically rounded, behind them there are short tempora. Ocelli small, forming an isosceles triangle; the distance between the posterior ocelli is more than half longer than the distance from the inner margin of the eyes and from the anterior ocellus (30: 20: 22). The crown suture distinct, the occipital furrow deep. Tubercles large, broadly oval, equally distant from the posterior ocelli and the inner margin of the eyes. The cuticle is fine, but with prominent reticulate wrinkles, and outside the tubercles and the M-shaped mark it is studded with scattered pits bearing bristles.

"Pronotum slightly trapezoidal, narrower in front than the occiput, a little widened posteriorly (50: 53: 47). Anterior and posterior borders broad, convex; sides straight. Middle furrow narrow but deep; the middle area very broad, occupying in the first third almost a fifth of the entire breadth, widened anteriorly and posteriorly. The structure is similar to that of the head.

"In the male the wings are greatly shortened, so that the anterior ones reach the posterior border of the second segment, and the posterior ones the posterior border of the third segment. In both sexes they are conspicuously smoked. The network in the tip of the wing occupies the space between radius, its sector, and the several branches of the same; but it is comparatively simple and composed of large, not very irregular cells. The inner inter-radial cell of the fore wing is a little more than once and a half as long as its base.

"In the male the ninth segment is prolonged into a yellow-brown, parabolic, subgenital plate, the tenth segment is cleft on the dorsal side with mallet-like processes. The other parts show no departure from the usual form.

"The female subgenital plate is short, semicircular, bright brown, and does not appear notched on the posterior margin.

"A pair in the collection of the Museum of London.

"This species is certainly very near *Arcynopteryx compacta* Mac Lachlan, but is distinguished by its darker color and smaller body." Translation from Klapálek.

Unknown to us.

Nymph unknown.

Arcynopteryx nymph—**"b"**

Immature nymph. Length to tip of abdomen, 22 mm.; length of antennae, 12 mm.

Distribution.—Las Vegas, New Mexico.

Color, yellowish brown, varied with paler markings. Head squarish, three small ocelli placed in an isosceles triangle, the base of which is about a third greater than sides, and equal to the distance between the inner margin of the eyes and the paired ocelli. Tubercles pale yellow, kidney-shaped; the M-shaped mark prominent, also pale yellow; a small median triangular pale spot confluent with the middle portion of the M; labrum and anterior border of the clypeus, white; pale yellow, oval-shaped spots on the lateral occipital areas; a faint indication of a median, occipital, triangular yellow spot reaching forward between the ocelli. Under side of head, palpi and antennae, pale yellow.

Pronotum as broad as the occiput, nearly twice as wide as long, sides and both margins convex, angles rounded; a narrow, median, pale line, lateral margins bordered with pale yellow, the inner halves of the lateral fields with pale sculpturings, the meso- and metanotum with similar markings. The entire venter of the thorax pale yellow. Legs also pale yellow. The outer margins of the femora and tibiae with thin fringes of long, fine, silky hairs. A single pair of finger-like tracheal gills placed far apart on the base of the submentum.

Abdomen brownish-yellow above, with three rows (a median one and on either side of it, a lateral one) of pale yellow spots, the spots on the last few segments are most conspicuous. The entire venter of abdomen and basal segments of the setae (all that remains of them) pale yellow. The tenth tergite triangularly produced; the supra-anal plate (fig. 57, Sup. A. P.) a rather large, fleshy lobe attached to the apical border of the last tergite; the sub-anal plates, (fig. 57, Sub. A. P.), triangular.

I am placing nymph "B" in the genus *Arcynopteryx* since it possesses a single pair of gills of the same form and in the same location in which they occur in two species of the adults of the genus.

Described from a single specimen from Las Vegas Hot Springs, New Mexico (T. D. A. Cockerell).

We have two other very young nymphs with a similar arrangement of gills but with different color patterns. They are too

immature, however, to warrant anything but mentioning. One of them is from Boulder, Colorado (T. D. A. Cockerell), X, 1905, and the other from Goat Creek, Ashford, Washington (Miss Hortense Butler), XI, 12, 1905. All of these specimens are at Cornell University, Ithaca, New York.

DICTYOGENUS Klapálek

1904. *Dictyogenus* Klapálek, Rozpr. Čes. Akad., 13, č. 17, p. 7.
1904. *Dictyogenus* Klapálek, Bull. Intern. Acad. Sci. Boheme, p. 7.
1912. *Dictyogenus* Klapálek, Coll. Selys, 4: 48.
"*Dictyopteryx* Pictet, Ris et auct. partim." Klapálek.

Klapálek characterizes this sub-genus as follows: "A more or less regular network of cross-veins in the tip of the wings; the distance between the posterior ocelli and the inner margin of the eyes at least two-thirds of the distance between them."

We have a single female specimen unlike any of the other species of the tribe in venation and coloration, which I am placing here as a possible member of the genus. The striking coloration, yellowish spotted with black, agrees well with that of some of the European species and the venation is like that of the European ones in so far as it is stated.

Dictyogenus? phaleratus Needham, new species

Adult

Distribution.—New Mexico.

"Length from head to base of cerci, 11.9 mm.; forewing, 14.5 mm.; hind wing, 12.8 mm.

"Color yellowish, phalerate with black; a broad, black triangle on frons, with apex rear; a large black four rayed spot on top of head, U-shaped in front, the hollow of the U surrounding the rear point of the frontal triangle, anterior rays running outward and backward to the eyes, posterior rays over-spreading the paired ocelli. Balance of head yellow, excepting two vertical tubercles and two smaller black, shining spots at lateral angles of frontal triangle.

"Prothorax quadrate, nearly twice as broad as long, with broad yellow median stripe divided with black on the middle suture and bordered outside by an obscure line of blackish, embossed markings; a few larger embossed markings farther out, half way to the lateral margin. Thorax broadly lined with black on all sutures. Legs, lineate with black on all carinae with a sharp transverse band at each joint and a diffuse one a little above each knee joint.

"Abdomen blackish on sides, yellowish beneath, with interrupted transverse rows of black dots across the middle of the segments." Quoted from Prof. Needham's manuscript.

In this species wings rather long and narrow; a scanty irregular, apical network of cross-veins occupying the region between the branches of the sector and media; the costal margin not showing a concavity at the humeral cross-vein; the entire costal area beyond the humeral cross-vein occupied by numerous cross-veins; subcosta passes into radius before the level of the cord, the length of the inner inter-radial cell only a fourth greater than its base; cord well developed; the first anal vein not angled at the base as in all other species of this tribe (fig. 65). Without gills.

Female. The posterior margin of the eighth ventral segment is evenly produced forming a short, broad, hemispherical vulvar lamina (fig. 56).

One female specimen from New Mexico and another from Florissant, Colorado, VI, 1907 (T. D. A. Cockerell). The specimen from New Mexico is the type of this species. It is at Cornell University in the entomological collection.

Abbreviations

Sub. A. P. Sub-anal plate.
Sup. A. P. Supra-anal plate, with the following parts:—
C. Sperm cup.
F. Free end.
I. Inner part.
L. Link.
L. B. Lateral brace.
L. S. Lateral stylet.
M. Muscle.
M. S. Median stylet.
P. G. P. Para-genital plate.
P. T. Protractile tendon.
R. T. Retractile tendon.
P. A. P. Para-anal plate.
S. Membranous sac.

EXPLANATION OF PLATES

Figs. 1–8, 10, 12–15, 20–26, 28–32, 34–36, 39, 41–44, 47–49, 51–57 drawn on the same scale to show relative size.

Figs. 27, 33 and 46 drawn on the same scale to show relative size.

Figs. 16–19, 37 and 38 drawn on the same scale to show relative size.

Figs. 11, 40, 45, 50 and text figures B, D and E drawn on the same scale to show relative size.

The same scale of magnification was not kept for the drawings of the wings (figs. 9, 58–65). Consequently the actual measurement is given in the explanation of each wing figure.

Plate XXIX

Fig. 1.—*Pteronarcys dorsata* Say. End of abdomen of adult ♂ in left lateral view.

Fig. 2.—*Pteronarcys dorsata* Say. End of abdomen of adult ♀ in ventral view.

Fig. 3.—*Pteronarcys nobilis* Hagen. End of abdomen of adult ♂ in left lateral view.

Fig. 4.—*Pteronarcys nobilis* Hagen. End of abdomen of adult ♀ in ventral view.

Fig. 5.—*Pteronarcys californica* Newport. End of abdomen of adult ♂ in left lateral view.

Fig. 6.—*Pteronarcys californica* Newport. End of abdomen of adult ♀ in ventral view.

Fig. 7.—*Pteronarcys princeps* Banks. End of abdomen of adult ♂ in left lateral view.

Fig. 8.—*Pteronarcys princeps* Banks. End of abdomen of adult ♀ in ventral view.

Plate XXX

Fig. 9.—*Pteronarcys dorsata* Say. ♀ adult wings. Length of fore-wing, 48 mm.

Fig. 10.—*Pteronarcys biloba* Newman. End of abdomen of adult ♀ in left lateral view.

Fig. 11.—*Pteronarcys proteus* Newman. Entire supra-anal plate of adult ♂ in left lateral view.

Fig. 12.—*Pteronarcys proteus* Newman. End of abdomen of adult ♂ in left lateral view.

Fig. 13.—*Pteronarcys proteus* Newman. End of abdomen of adult ♀ in ventral view.

Fig. 14.—*Pteronarcys biloba* Newman. End of abdomen of adult ♂ in left lateral view.

Fig. 15.—*Pteronarcys comstocki* new species. End of abdomen of adult ♀ in ventral view.

Fig. 16.—*Pteronarcys proteus* Newman. Outline of prothorax of nymph.

Fig. 17.—*Pteronarcys dorsata* Say. Outline of prothorax of nymph.

Fig. 18.—*Pteronarcys biloba* Newman. Outline of prothorax of nymph.

Fig. 19.—*Pteronarcys californica* Newport. Outline of prothorax of nymph.

Plate XXXI

Fig. 20.—*Pteronarcys dorsata* Say. End of abdomen of ♂ nymph in left lateral view.

Fig. 21.—*Pteronarcys dorsata* Say. End of abdomen of ♀ nymph in left lateral view.

Fig. 22.—*Pteronarcys californica* Newport. End of abdomen of ♂ nymph in left lateral view.

Fig. 23.—*Pteronarcys californica* Newport. End of abdomen of ♀ nymph in left lateral view.

Fig. 24.—*Pteronarcys proteus* Newman. End of abdomen of ♂ nymph in left lateral view.

Fig. 25.—*Pteronarcys proteus* Newman. End of abdomen of ♀ nymph in left lateral view.

Fig. 26.—*Pteronarcys biloba* Newman. End of abdomen of ♀ nymph in left lateral view.

Fig. 27.—Diagram to show arrangement of gills in genus *Pteronarcys*.

Fig. 28.—*Pteronarcella regularis* Hagen. End of abdomen of adult ♂ in dorsal view.

Fig. 29.—*Pteronarcella regularis* Hagen. End of abdomen of adult ♀ in ventral view.

Plate XXXII

Fig. 30.—*Pteronarcella torosa* new species. End of abdomen of adult ♂ in dorsal view.

Fig. 31.—*Pteronarcella triloba* new species. End of abdomen of adult ♀ in ventral view.

Fig. 32.—*Pteronarcella badia* Hagen. End of abdomen of adult ♀ in ventral view.

Fig. 33.—Diagram to show arrangement of gills in genus *Pteronarcella*.

Fig. 34.—*Pteronarcella torosa* new species. End of abdomen of ♂ nymph in left lateral view.

Fig. 35.—*Pteronarcella torosa* new species. End of abdomen of ♀ nymph in left lateral view.

Fig. 36.—*Pteronarcella* nymph "a". End of abdomen of ♀ in left lateral view.

Fig. 37.—*Pteronarcella torosa* new species. Outline of prothorax of nymph.

Fig. 38.—*Pteronarcella* nymph "a". Outline of prothorax.

Fig. 39.—*Protarcys dolobrata* new species. End of abdomen of adult ♂ in ventral view.

Fig. 40.—*Protarcys bradleyi* new species. Entire supra-anal plate of adult ♂ in left lateral view.

Fig. 41.—*Protarcys bradleyi* new species. End of abdomen of adult ♂ in dorsal view.

Fig. 42.—*Protarcys bradleyi* new species. End of abdomen of adult ♀ in ventral view.

Fig. 43.—*Megarcys signata* Hagen. End of abdomen of adult ♂ in dorsal view.

Fig. 44.—*Megarcys signata* Hagen. End of abdomen of adult ♀ in ventral view.

Plate XXXIII

Fig. 45.—*Megarcys signata* Hagen. Entire supra-anal plate of adult ♂ in left lateral view.

Fig. 46.—*Megarcys signata* Hagen. Diagram to show arrangement of gills.

Fig. 47.—*Megarcys signata* Hagen. End of abdomen of nymph in left lateral view.

Fig. 48.—*Arcynopteryx lineata* new species. End of abdomen of adult ♀ in ventral view.

Fig. 49.—*Arcynopteryx aurea* new species. End of abdomen of adult ♀ in ventral view.

Fig. 50.—*Arcynopteryx vagans* new species. Entire supra-anal plate of adult ♂ in left lateral view.

Fig. 51.—*Arcynopteryx vagans* new species. End of abdomen of adult ♂ in dorsal view.

Fig. 52.—*Arcynopteryx ignota* new species. End of abdomen of adult ♀ in ventral view.

Fig. 53.—*Arcynopteryx inornata* new species. End of abdomen of adult ♀ in ventral view.

Fig. 54.—*Arcynopteryx americana* Klapálek. End of abdomen of ♂ in dorsal view. After Klapálek.

Fig. 55.—*Arcynopteryx americana* Klapálek. End of abdomen of adult ♀ in ventral view.

Fig. 56.—*Dictyogenus? phaleratus* Needham, new species. End of abdomen of adult ♀ in ventral view.

Fig. 57.—*Arcynopteryx* nymph "b". End of abdomen in left lateral view.

Plate XXXIV

Fig. 58.—*Pteronarcella regularis* Hagen. ♂ Adult wings. Length of fore-wing, 18 mm.

Fig. 59.—*Protarcys dolobrata* new species. ♀ Adult wings. Length of fore-wing, 21 mm.

Fig. 60.—*Protarcys bradleyi* new species. ♂ Adult wings. Length of fore-wing, 15 mm.

Fig. 61.—*Megarcys signata* Hagen. ♀ Adult wings. Length of fore-wing, 18 mm.

Fig. 62.—*Arcynopteryx inornata* new species. ♀ Adult wings. Length of fore-wing, 13 mm.

Fig. 63.—*Arcynopteryx vagans* new species. ♂ Adult wings. Length of fore-wings, 12 mm.

Fig. 64.—*Arcynopteryx aurea* new species. ♀ Adult wings. Length of fore-wing, 16 mm.

Fig. 65.—*Dictyogenus? phaleratus* Needham, new species. ♀ Adult wings. Length of fore-wing, 15 mm.